INTEGRATED ATMOSPHERIC DEPOSITION NETWORK

QUALITY ASSURANCE PROGRAM PLAN

Environment Canada
United States Environmental Protection Agency
Ontario Ministry of Environment and Energy

January 31, 1994

Canada/U.S. Great Lakes Water Quality Agreement
Integrated Atmospheric Deposition Network (IADN)

The attached Quality Assurance Program Plan (QAPP) for the Integrated Atmospheric Deposition Network is hereby recommended for approval.

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Date ______________________

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LIST OF ACRONYMS

ADQ	Audit of Data Quality
AES	Atmospheric Environment Service (Canada)
AIRS	Aerometric Information Retrieval System
APIOS	Acidic Precipitation in Ontario Study
AREAL	Atmospheric Research and Exposure Assessment Laboratory
CAA	United States Clean Air Act
CAPMoN	Canadian Air and Precipitation Monitoring Network
CCIW	Canada Center for Inland Waters
COA	Canada - Ontario Agreement
DBM	Database Manager
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Environment Canada
GC/MS	Gas Chromatograph / Mass Spectrometry
GC/ECD	Gas Chromatograph / Electron Capture Detector
GLAD	Great Lakes Atmospheric Deposition (U.S.)
GLEO	Great Lakes Environment Office (Canada)
GLNPO	Great Lakes National Program Office (U.S.)
GLWQA	Great Lakes Water Quality Agreement
HCB	Hexachlorobenzene
HCH	Hexachlorocyclohexane
IADN	Integrated Atmospheric Deposition Network
IDL	Instrument Detection Limit
IJC	International Joint Commission
ILOD	Interim Limit of Detection
IMIS	IADN (laboratory) Measurement Intercomparison Study
ISWS	Illinois State Water Survey (U.S.)
IWD	Inland Waters Directorate (Canada)
LOD	Limit of Detection
MDL	Method Detection Limit
MQO	Measurement Quality Objective
MSR	Management Systems Review
NLET	National Laboratory for Environmental Testing (Canada)
NWRI	National Water Research Institute (Canada)
MOEE	Ontario Ministry of Environment and Energy (Canada)
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PE	Performance Evaluation
PD	Project Director
PI	Principal Investigator
PM	Program Manager
PMG	IADN Program Management Group
QA	Quality Assurance

LIST OF ACRONYMS (Continued)

QAM	Quality Assurance Manager
QAMS	Quality Assurance Management Staff
QAO	Quality Assurance Officer
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
QC	Quality Control

QCC	Quality Control Coordinator
SOP	Standard Operating Procedure
TOC	Total Organic Carbon
TSA	Technical Systems Audit
TSP	Total Suspended Particulate Matter
U.S. EPA	U.S. Environmental Protection Agency

SECTION 1.0

INTRODUCTION

1.1 BACKGROUND

The quality of water in the Great Lakes has been a subject of concern to both Canada and the United States since the early 20th century. In response to this concern, the International Joint Commission (IJC) and the Boundary Waters Treaty were created in the mid-1900's. The Great Lakes Water Quality Agreement (GLWQA) was enacted in 1972. During the 1970's, studies spurred by the GLWQA showed that a number of pollutants created a potential threat to the Great Lakes ecosystem, and that atmospheric deposition may be a major route of introduction for these pollutants to the lakes.

In 1987, a new protocol was signed and several annexes were added to the GLWQA, including Annex 15, which specifically addresses airborne toxic substances, including research, surveillance and monitoring, controls, and health effects. In response to Annex 15, the International Joint Commission, in a 1988 report, outlined a plan regarding airborne toxics. Central to the plan was the creation of an Integrated Atmospheric Deposition Network (IADN), comprised of both U.S. and Canadian monitoring stations. The United States involvement in this effort was accelerated by the 1990 amendments to the United States Clean Air Act (CAA), which added impetus to the program through Title III, Section 112 (m), which called for the establishment of a Great Lakes atmospheric deposition monitoring network.

In 1971, the first Canada-Ontario Agreement on Great Lakes Water Quality (COA) was signed. The COA has been renewed several times and reflects a continuing commitment between Federal and Provincial governments to the improvement of water quality in the Great Lakes. The COA provides the basis for the Ontario Ministry of Environment and Energy's participation in the IADN Program.

1.2 SCOPE AND PURPOSE

Because of the multiple parties involved in data collection activities for the IADN, a comprehensive program-wide quality assurance plan is essential. This document outlines the elements of such a program, and delineates the QA activities that are essential in order to produce data of sufficient quality to meet the program goals.

This Quality Assurance Program Plan (QAPP) is intended to be a "living document," flexible enough to accommodate any changes in techniques and goals that may occur as the IADN program develops. This document has been designed to allow for easy revision to reflect program changes.

Details of sampling and analytical techniques, data management procedures, and other matters related to the data collection activities are covered in the Quality Assurance Project Plans (QAPjP), Standard Operating Procedures (SOP), and technical manuals developed by each group performing data collection activities. This QAPP contains information of a more general nature regarding QA requirements for all parties involved in the IADN. QAPPs and QAPjPs should work together as an integrated whole, covering all aspects of a complete QA program for the IADN. Appendix A is a glossary of quality assurance and related terms used in this document.

1.3 RATIONALE AND APPROACH

The requirements of the IADN have been examined and, within the Annex 15 community, the mass balance approach is the accepted method for estimating the relative importance of the various pathways for toxic contaminants into the Great Lakes. The IADN will supply information on entry of toxic pollutants into the lakes through wet and dry atmospheric deposition.

As stated in the IADN Implementation Plan (see Appendix B) the objective of the Integrated Atmospheric Deposition Network is "to acquire sufficient, quality assured data to estimate with a specified degree of confidence the loading to the Great Lakes Basin of selected toxic substances." The IADN is to focus on atmospheric deposition and allow for comparison to the loadings resulting from other sources. The model that will be used to determine atmospheric loadings contains six major terms:

$$L = L_t + P + G + D + RS + F$$

where:

L	=	Total atmospheric loading
L_t	=	Atmospheric component of tributary loading to lake
P	=	Precipitation component of loading to lake
G	=	Net gas phase transfer component of loading to lake
D	=	Dry deposition of particulates to lake
RS	=	Resuspension of particles from lake into air
F	=	Fog component of loading to lake

(Details of the terms in this model may be found in Appendix C)

The Data Interpretation Workgroup (see Section 3.3) will provide estimates of loading using this equation as a guide. The IADN network provides direct measurements for only some of the above components. Participating organizations, as part of their research programs, will fund special projects to identify missing elements and those parameters leading to the greatest uncertainty in loading estimates, and to provide information to fill in these gaps and reduce uncertainties.

The IADN Implementation Plan (the Plan) outlines the development of the network and lists the substances to be examined in the initial phase of the IADN program. The Plan also contains a description of the criteria to be used in choosing which toxics are to be monitored by IADN. These criteria include evidence of the pollutant in the atmosphere, and feasibility of routine monitoring. The Plan also requires that regional source attribution questions are addressed where possible.

The IADN will consist of one master research-grade station per lake supported by a number of satellite stations. The master stations are to be equipped with replicated and sometimes collocated samplers, while satellite stations will typically have a single set of instruments. Master stations and some satellite stations are to be equipped with instruments to record meteorological information. There are two major types of sampling instruments in use: precipitation collectors for wet deposition, and air samplers to measure toxics in the particulate and vapor phases. However, there are variations among the specific samplers used by the different groups.

In order to evaluate and compare the various sampling equipment and techniques used by the groups involved in data collection for the IADN, the Pt. Petre master station has been provided with collocated sampling equipment from each group and replicate samplers.

The satellite stations will serve to increase the spatial resolution of the network and may often be formed from existing sites that are part of other monitoring programs, provided that these sites meet the IADN siting criteria (see Appendix D) and their analytical methodology is comparable to those used in the IADN program. Each satellite station will have one set of samplers and meteorological instruments.

A central IADN database will be developed to store the data collected at the master and satellite stations. All data will be carefully screened and evaluated before being entered into the database. The validated data entered into the database will be generally available to both government and private users. During the interim period, national databases will set up by Canada and the U.S.

SECTION 2.0
QUALITY ASSURANCE POLICY STATEMENT

The IADN involves coordination of multiple Federal and Provincial/State agencies in both the United States and Canada, and makes use of state-of-the-science methods for sampling and analysis which do not have standardized operational techniques or routine protocols. The IADN Implementation Plan requires that agencies participating in the IADN produce data of comparable quality which meet clearly defined quality assurance objectives.

The Plan calls for clear data quality objectives to be set for each chemical (or group of chemicals) to be monitored on a routine or research basis. These data quality objectives (DQOs) are to take into account the stated purpose of the IADN, which is assessment of the loading of toxics to the Great Lakes through atmospheric deposition. These DQOs will regulate the entire measurement process, including sampling, analysis, and data reduction and reporting, and will be used as the basis for the final acceptance of data from a given agency.

The agencies participating in IADN commit to work together to meet the quality assurance objectives described in this QA Program Plan and to provide data of acceptable quality through compliance with the quality assurance procedures described in this document and through implementation of their own Quality Assurance Project Plans (or equivalent documents).

SECTION 3.0
ORGANIZATION AND RESPONSIBILITIES

The United States' Great Lakes National Program Office (GLNPO) and Canada's Great Lakes Environment Office (GLEO) are primarily responsible for management and oversight of their respective portions of the IADN program. The framework for U.S.-Canadian cooperation is provided by the Great Lakes Water Quality Agreement. The International Joint Commission is responsible for reviewing the IADN program to ensure it remains consistent with the objectives of the GLWQA.

For the United States, GLNPO will be assisted by EPA's Atmospheric Research and Exposure Assessment Laboratory (AREAL) and the Illinois State Water Survey (ISWS). AREAL will be responsible for assistance with the scientific aspects of the monitoring program, and the efficient use of resources relative to the ultimate delivery of useful data. ISWS has a grant to conduct data collection activities, including field sampling and laboratory analysis.

For Canada, several Federal and Provincial agencies are involved within a framework for cooperation provided by the Canada-Ontario Agreement (COA). Several agencies within Environment Canada (EC) have varying responsibilities for monitoring and analysis. The Atmospheric Environment Service (AES) has primary responsibility for field operations and for laboratory analysis for their vapor and particulate samplers. In addition, the AES operates inorganic precipitation samplers under the CAPMoN protocols (with their own QA documentation, see Reference Section). Two other agencies within EC, the Inland Waters Directorate (IWD) and the National Water Research Institute (NWRI), are responsible for monitoring of wet deposition and analyses of organics and trace metals in precipitation samples from their sampling devices. Analyses of samples for IWD is performed by the National Laboratory for Environmental Testing (NLET).

The Ontario Ministry of Environment and Energy (MOEE) is the Provincial agency participating in IADN. The MOEE has an existing toxics monitoring network which monitors toxics in both air and precipitation. A committee has been organized under COA to coordinate the activities of the Canadian agencies, both Federal and Provincial.

This QA Program Plan contains provisions for organizing several binational workgroups to promote communication and cooperation among the various agencies involved in data collection for IADN. These binational workgroups shall include a program management group and workgroups for field and laboratory operations, quality assurance, data interpretation, and data management.

Section 3.1 describes the organization of the IADN program. Sections 3.2, 3.3, and 3.4 describe the responsibilities of the participating agencies, interagency workgroups, and agency personnel, respectively. Appendix E contains an annual timetable for the IADN, including requirements for data delivery, audits, and reports.

3.1 ORGANIZATIONAL CHARTS

Figure 3-1 is a functional organizational chart for the IADN showing the relationships among the participating agencies. Appendix F contains more detailed organizational charts for each agency. Figure 3-2 shows the organization of the binational workgroups.

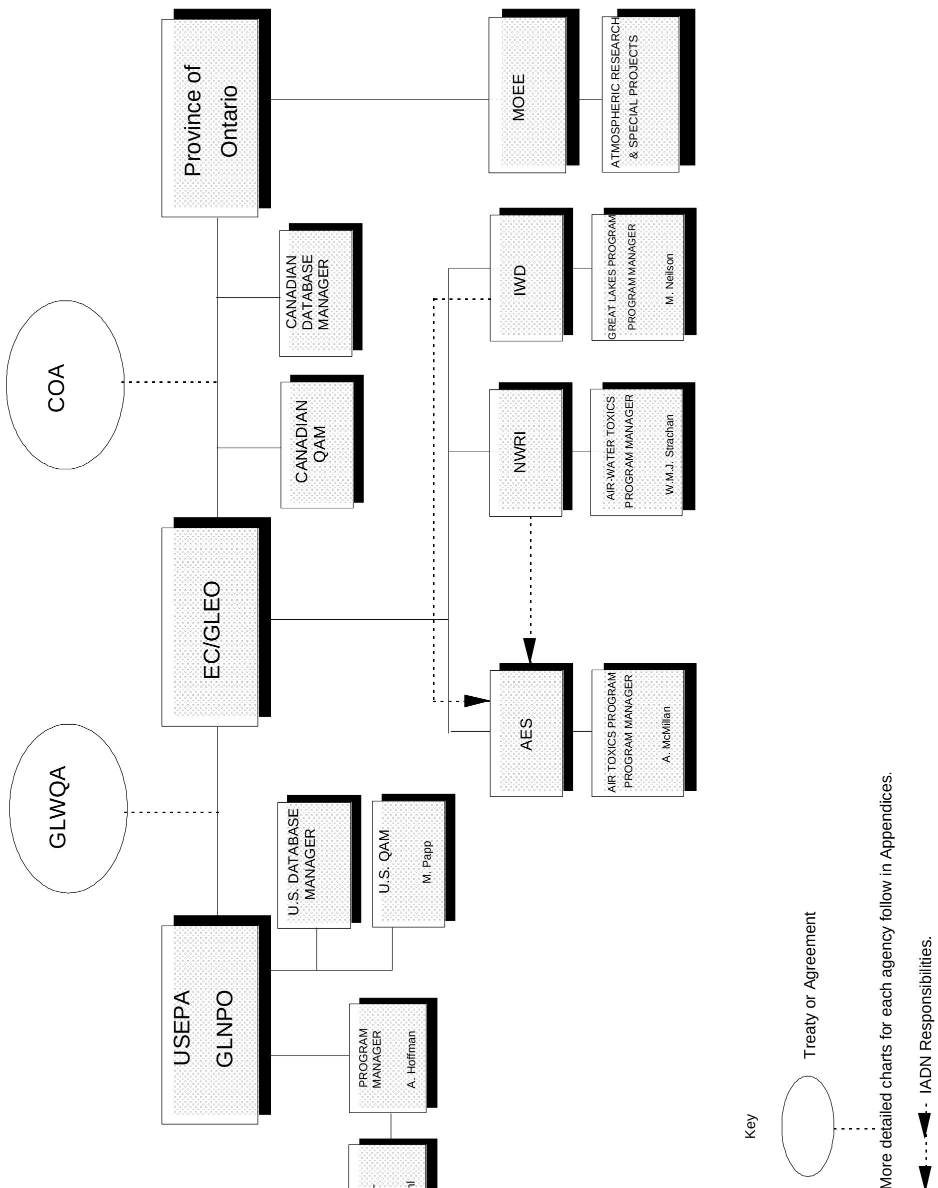

Figure 3-1. IADN Program Management Structure.

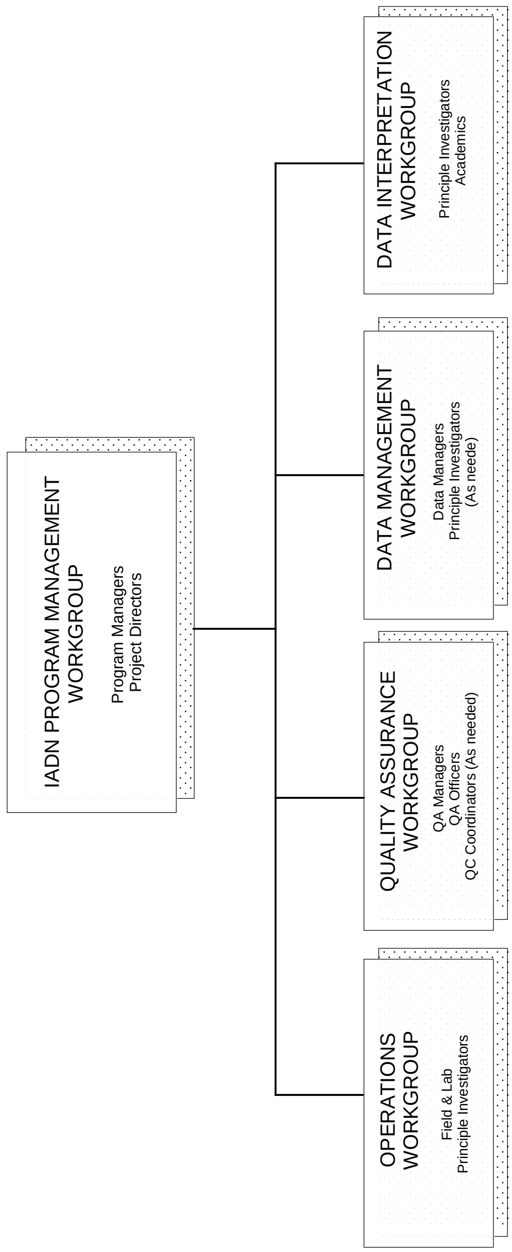

FIGURE 3-2. Organizational Structure for Binational Management/Operational Committees for IADN Program

3.2 RESPONSIBILITIES OF PARTICIPATING AGENCIES

3.2.1 Monitoring Responsibilities under Annex 15

Currently, five separate agencies are involved in monitoring activities as part of IADN : Environment Canada's AES, IWD, and NWRI; the MOEE; and the U.S. EPA. Each agency has its own monitoring and research programs, and there are some variations among the agencies regarding which pollutants and atmospheric pathways are investigated.

The AES operates and maintains the Canadian master stations and is in charge of routine field operations for the Canadian portion of the IADN. They operate air samplers at all the master stations which collect suspended particulates and aerosols. These samples are analyzed (internally or by a subcontractor) for organics, metals, total suspended particulate matter (TSP), and total organic carbon (TOC). The AES is also responsible for collecting on-site meteorological data at the Canadian master stations.

The Inland Waters Directorate of EC operates an organic precipitation network in the Great Lakes Basin, with samplers at the two Canadian Master Stations. Samples collected by the IWD are analyzed by the National Laboratory for Environmental Testing (NLET). The National Water Research Institute of EC, while also operating precipitation samplers at the Canadian master stations, has a broader role in research directed at Annex 15 of the GLWQA. The NWRI sends precipitation samples for analysis of trace metals to the NLET, but performs organics analyses internally.

The MOEE operates several monitoring programs in the Great Lakes Basin and throughout Ontario. Some sites established for the MOEE's Toxic Deposition Monitoring Program and Acid Precipitation in Ontario Study (APIOS) may serve as IADN satellite stations in the future. The Toxic Deposition Monitoring Network collects both air and precipitation samples at its own sites and at the Pt. Petre master station. The Toxic Deposition Monitoring Network's samples are analyzed for organics and metals by the MOEE's Laboratory Services Branch.

The U.S.EPA's GLNPO and AREAL are responsible for IADN monitoring and sample analysis. As the lead office within EPA for the Great Lakes Program, GLNPO is responsible for U.S. IADN program management and quality assurance. As the lead laboratory within EPA for air toxics measurement methods, monitoring, modelling, and assessment, AREAL provides scientific guidance and research for the U.S. IADN program.

To provide the highest possible level of standardization in U.S. IADN monitoring and sample analysis, GLNPO and AREAL work with a primary contractor. Currently, the ISWS performs these functions under a grant from the EPA. Samples collected by the ISWS are analyzed for organics, metals, TOC, and TSP. Organics analyses are performed by ISWS and metals are analyzed by other contractors.

3.2.2 Coordination Among Agencies

It is essential that the agencies which comprise the IADN work cooperatively. The Program Manager (PM) from each agency will be a part of the IADN Program Management Group. The appropriate staff members of each agency will take part in the inter-agency workgroups, including operations, data management, QA, data interpretation, and any ad hoc workgroups that may be created. Agencies performing monitoring activities as part of the IADN will also take part in any program-wide sampling or analytical measurement studies, audits, and data reviews. Outside groups participating in IADN-related comparison studies, etc. shall adhere to IADN QA standards as described in this QAPP.

Effective communication and exchange of information among the agencies participating in the IADN are essential for the network to function as a coordinated whole. The Program Management Group shall develop a mechanism to keep IADN participants aware of current events within the network, such as changes in personnel or operating procedures by one of the participating agencies, or current research projects. This may be accomplished by a newsletter or computer bulletin board.

In addition to the responsibilities described in this section, there will be other duties required of agencies participating in the IADN. Systems and performance audits will be performed on a regular basis for all IADN participants. Agencies and contractors, grantees, and subcontractors will also take part in intercomparison studies of sampling and analytical techniques. Ad hoc studies and audits may be performed from time to time, and all agencies involved in IADN will participate.

3.2.3 Delivery of Data

Each agency will be responsible for delivery of available quality assured data to the national IADN databases at six month intervals (*i.e.*, by June 30 and December 31), followed by international exchange of the validated data. The data are to be translated into the proper format for the IADN database with flagged data points coded with the proper IADN validation codes. Agencies should provide valid data within a one-year turnaround period for each calender year.

3.2.4 Documentation

Proper documentation of all aspects of network operations is essential to an effective QA program. Table 3-1 is a summary of the recommended IADN documentation requirements. Appendix E provides a time frame for completion of annually produced reports.

3.3 COMMITTEE/WORKGROUP MEMBERSHIP AND RESPONSIBILITIES

The management structure for the IADN coordinates operations of the agencies implementing the program and promotes consistency of methods whenever possible. Four major areas that require coordination are sampling and analysis techniques, quality assurance, data interpretation, and data management. Workgroups will be formed from members of all the agencies involved in data collection for the IADN program. It is expected that there will be significant overlap in the membership of these workgroups. Appendix G lists current members of the workgroups and their addresses and telephone and fax numbers.

The membership and responsibilities of the groups to be formed are described in this subsection. These groups will meet on a semi-annual basis and should maintain more frequent contact with monthly conference calls.

IADN Program Management Group (PMG)

This group is composed of Program Managers and Project Directors or their equivalent from each agency involved in data collection for IADN. The chairs (or designated members) of the other workgroups shall sit on all PMG meetings. The members of the PMG will elect a chairman. Responsibilities of the IADN PMG include:

Coordinate cooperation between various agencies
Oversee and manage the IADN program
Ensure development and maintenance of QAPP
Advocate allocation of resources
Develop and update DQOs
Review and approve deposition estimates and biennial reports

The PMG will also be responsible for coordination with other Federal, Provincial, State, or local agencies for information exchange or other cooperative efforts. The PMG shall name representatives to work with other groups, and attend meetings and conferences or any other function deemed necessary.

Operations Workgroup

This workgroup is composed of Principal Investigators or persons who are directly in charge of daily operations for data collection activities. The chair is elected by the members. Responsibilities of the Operations Workgroup include:

Operate the IADN

Encourage standardization of field and laboratory operations where possible

Review logistics and coordinate sampling schedules

Coordinate and document changes in procedure/criteria

Review data

Review and compare methods

Review and update siting criteria

Report to the IADN Program Management Group

Cooperate with the other IADN workgroups

Quality Assurance Workgroup

This workgroup is comprised of Program QA Managers, and Project QA Officers or their equivalents. Laboratory QC Coordinators may be included as needed. The IADN QA Managers shall serve as co-chairs. The responsibilities of the QA Workgroup include:

Ensure that the IADN QAPP is developed, implemented and updated annually

Schedule and arrange external audits of sites, laboratories, and the data management centers

Coordinate interlaboratory and field sampling comparisons

Provide oversight for data reviews and corrections to the IADN database

Develop data validation criteria

Assess compliance with DQOs

Prepare a QA synthesis report every five years

Report to the IADN PMG

Review and approve agency QAPPs and QAPjPs (or equivalents)

Cooperate with the other IADN workgroups

Investigate implementation of central repository of calibration and reference standards

Data Management Workgroup

The Data Management Workgroup consists of data managers and people responsible for database development and maintenance. Principal Investigators may participate as needed. The IADN Database Manager serves as chair. Responsibilities of the Data Management Workgroup include:

Develop an IADN standard for data submission (including a minimum set of uniform acceptability flags and comment codes, and a suggested data submission format)

Develop users guide for database

Develop format and schedule for data deliveries

Coordinate data reviews and data corrections

Maintain archive of IADN program documentation (hard copy and magnetic media)

Report to IADN PMG

Ensure integration of databases

Cooperate with the other IADN workgroups

Data Interpretation Workgroup

The Data Interpretation Workgroup is composed of Principal Investigators and members of the academic community to be appointed by the PMG. Responsibilities of the Data Interpretation Workgroup include:

Develop loading estimates for the Great Lakes

Document loading models used, including assumptions made and values of parameters

Assess the significance of the IADN data with respect to annual and relative loadings

Assess the adequacy of the measurement process

Assess parameters for measurement

Develop DQO's

Prepare data interpretation and summary reports

Report to the IADN PMG

Cooperate with the other IADN workgroups

Ad Hoc Workgroups

The IADN PMG may form ad hoc workgroups as needed to address specific concerns. These groups will meet as long as necessary to meet their objectives and then disband.

3.4 RESPONSIBILITIES OF INDIVIDUALS

The positions described in this section are divided by areas and levels of responsibility. Ideally each might be a full time position. However, in practice a single person may be responsible for more than one position (*e.g.*, Principal Investigator and agency database manager). When this is the case, the person is responsible for all the duties of each position they fill.

Program Managers (PM)

These individuals may have various titles (Program or Project Manager, Program Leader, Network Coordinator) depending on the agency they are associated with, but they are generally identified by their managerial roles and association with the agencies providing funding and support to the groups performing the monitoring and analysis (GLNPO, EC, AES, NWRI, IWD, MOEE). Responsibilities of the Program Managers include:

Coordinate and allocate resources
Ensure that QA requirements are met
Ensure development and approval of DQOs
Ensure corrective actions are taken
Review and approve all QA documents
Review and approve all IADN reports
Review and evaluate QA implementation and progress
Serve as member of the IADN PMG

Principal Investigators (PI)

The Principal Investigators are directly in charge of the data collection activities (for EPA, AES, IWD, NWRI, and MOEE). Duties of the PI include:

Ensure efficient operation of their network
Ensure that QA/QC requirements are met
Review and approve QA documentation
Develop the QAPjP with the QAO
Prepare and deliver reports to the PM
Develop Site Operator's Manual, Technical Manual and other SOP's
Report data quality problems to the PM and IADN QAM
Take necessary corrective action
Analyze data
Deliver data to the IADN database(s)
Serve as a member of the Operations Workgroup
Serve as a member of the Data Interpretation Workgroup

Quality Assurance Manager (QAM)(Program-Wide)

Overall QA management of the IADN program will be the responsibility of two national QA Managers, one for the U.S. agencies and one for the Canadian agencies. Preferably, the QAMs should be full-time positions. These QAMs will use the QA workgroup for assistance and may secure the services of contractors, as needed. Responsibilities of the QAMs include:

Track the QA/QC status of projects within IADN
Provide assistance with audits

Maintain central QA documentation files and provide copies to the data archive

Review and revise the QAPP annually

Prepare and submit an annual QA report and QA plan for upcoming year (with PIs)

Confirm training of agency personnel (field, laboratory and other), including periodic reviews

Periodically review agency QAPP's and QAPjP's

Encourage and assist continual development of improved QA/QC systems and techniques

Organize field and laboratory intercomparisons

Assist in development of audit protocols

Periodically review and approve audit protocols

Serve as co-chair of QA Workgroup

Prepare a QA synthesis report every five years

Review data with PIs prior to inclusion in the IADN database

Report to the IADN PMG

QA Officer (QAO)

The QAOs execute the QA activities within their own agency. Their responsibilities include:

Review and assess field and laboratory data quality regularly

Schedule and arrange internal audits

Report data quality problems and audit results to PI and IADN QAM

Prepare an annual QA report and QA plan for upcoming year (with QAM)

Maintain an archive of QA documentation and a record of changes and revisions to them

Assist PI in preparing QAPjP and/or SOPs

Serve as a member of QA Workgroup

Laboratory Quality Control Coordinators (QCC)

In some laboratories the role of the laboratory QCC may be assumed by the Laboratory Manager. Laboratory QCCs are responsible for ensuring that proper care is taken in the analysis of samples to produce quality data. Responsibilities of the QCC include:

Ensure that proper QC measures are taken

Assist in preparation of Standard Operating Procedures (SOPs)

Prepare the Laboratory Operations Manual

Maintain records of all QC activities

Notify the PI, QAO, and IADN QAM of any changes or revisions to SOPs

Report all QA/QC problems and solutions to the PI, QAO, and IADN QAM

Participate in the QA Workgroup (as necessary)

IADN Database Managers (DBM)

There are two IADN DBMs, one American and one Canadian. The IADN DBMs are responsible for maintaining the national IADN databases. The IADN DBMs should have a scientific background. The responsibilities of the IADN DBMs include:

Establish the IADN databases
Validate, update, and correct all data submitted by data collection groups
Maintain a central QA documentation archive
Provide support for database users
Create products (*e.g.*, data summaries, maps)
Serve as co-chair of the Data Management Workgroup
Ensure comparability and security of the national IADN databases
Report to the IADN PMG

Agency Database Managers

Database managers are responsible for storing the data produced by their group and transmitting it to the central IADN databases. Database Managers have responsibilities including the following:

Maintain the database for their agency
Ensure that all data entered into the database meet specified criteria
Translate data into proper format for the central IADN databases
Serve as a member of the Data Management Workgroup

SECTION 4.0
DATA GENERATION AND MANAGEMENT

This section addresses QA/QC procedures related to the collection and management of IADN data. Section 4.1 describes the means that will be used to assess the quality of the data generated by the IADN. Sections 4.2 and 4.3 describe the QA documentation that is required of all agencies that will be contributing data to the IADN. (Appendix H expands on section 4.3, providing details of certain topics not discussed elsewhere in this QAPP in order to ensure consistency of methods between the numerous agencies participating in IADN). Section 4.4 outlines the IADN data management system, including the general design of the database, data reduction methodology, and QC procedures for data management. Section 4.5 addresses data submittal, including frequency and format requirements. Section 4.6 covers the responsibility of the Database Managers to make the data available to the scientific community and the public, including data retrieval and reporting requirements.

4.1 DATA QUALITY OBJECTIVES

The PMG, with the assistance of the Data Management and Data Interpretation Workgroups, will be responsible for setting clear DQOs for the IADN program. However, DQO development is a time consuming and complex process and there is an urgent need for a means to assess the quality of the data currently being generated by IADN participants. Because of this situation, DQOs will be implemented in a two-phase process. During the first phase, data quality will be assessed by the use of Data Quality Indicators (DQIs) with acceptance criteria based on the current state-of-the-art in measurement technology. Development of true DQOs will also proceed during phase one. The second phase will be marked by implementation of the DQOs developed during phase one.

The stated purpose of the IADN is to assess loading of toxics to the Great Lakes through atmospheric pathways with a certified degree of confidence. The model to be used to assess atmospheric loadings is based on the following equation:

$$L = L_t + P + G + D + RS + F$$

where:

L	=	Total atmospheric loading
L_t	=	Atmospheric component of tributary loading to lake
P	=	Precipitation component of loading to lake
G	=	Net gas phase transfer component of loading to lake
D	=	Dry deposition of particulates to lake
RS	=	Resuspension of particles from lake into air
F	=	Fog component of loading to lake

(Details of the terms in this model may be found in Appendix C)

In order to achieve the stated program goal, the concentrations, constants, and parameters which contribute to the terms of the loading equation must also be known to a specified degree of confidence. The monitoring methodology used for the IADN is still evolving, and it is quite possible that measurement methods currently in use will change as a result of ongoing research projects. At a workshop held at Research Triangle Park, North Carolina in November 1992, a proposal was made that in order to be acceptable, loadings should be determined to target value of within 20-30 percent. For most compounds, this is not likely to be achieved with current monitoring methods. Because of this situation and the need for QA objectives to be set for data currently being collected, DQOs for the IADN will be implemented in two stages.

Stage I

In order to allow time for further methods evaluation and development of DQOs, the first phase of DQO implementation will rely on DQI goals based on results achievable with the current state-of-the-art in measurement technology. Appendix I details the current DQI goals. These DQIs are to be replaced by DQOs when they can be determined and implemented. During Stage I, methods development and DQO development will be important concerns for IADN workgroups to address. In summary, the results of the first phase of the DQO implementation process will be :

Data quality assessed against DQI goals
Development of DQOs for Stage II
Performance of sensitivity analyses for model equation inputs and parameters
Improved monitoring methods

Stage II

Stage II will be marked by the implementation of the DQOs developed in Stage I. The parameters to be measured by the IADN are to be clearly defined, and based on the model to be used in determining loading to the Great Lakes (see Section 1.3 and Appendix C).

The DQOs will contain explicit pollutant-specific objectives for acceptable uncertainty in seasonal and annual loadings of toxic compounds in air and precipitation. These objectives will reflect the uncertainty that is allowable in the decisions that are to be made based on IADN data. The use of DQOs will entail a coordinated effort to improve monitoring methods, as appropriate, and to better determine model parameters.

4.2 QUALITY ASSURANCE PROJECT PLANS

Each agency performing data collection activities as a part of IADN must have a clearly written QA Project Plan (QAPjP) or equivalent document. This includes all groups whose sites are used as satellite stations or who are operating sampling equipment at any of the master stations. The projects requiring a QAPjP include:

AES - Semi-Routine Monitoring Program
MOEE - Toxic Deposition Monitoring
ISWS - Toxic Deposition Monitoring
IWD - Precipitation Monitoring
NWRI - Air-Water Toxics Program

The following list includes the essential elements which must be covered by a QAPjP. (See Appendix H for details on each point)

Project description
Project organization and responsibility
DQOs for measurement data
Sampling procedures and siting criteria
Sample custody
Calibration procedures
Analytical procedures
Data reduction, validation, and reporting
Internal Quality Control checks
Performance and system audits
Preventive maintenance
Specific routine procedures to assess DQIs:
precision, accuracy, representativeness, completeness, and comparability (PARCC)
Corrective action
QA reports to management
QA for special studies

Canadian agencies are not required to comply with the format constraints imposed on QAPjPs for U.S. environmental data collection activities: they may organize the QA requirements in some other manner. However, they will address the content requirements listed above. The QAPjP may reference SOPs or other technical manuals for details of specific procedures, but should still contain a brief description of each subject.

The PI is responsible for ensuring that the QAPjP (or equivalent) is developed and revised annually (or as needed). The QAO is responsible for maintaining an updated hard copy of the QAPjP and a record of any changes as part of the QA documentation archive. The QAO is to provide copies to the IADN QAM and Database Manager. The IADN QA Workgroup is responsible for assessing the effectiveness of each agency's QAPjP in achieving quality assurance goals.

4.3 STANDARD OPERATING PROCEDURES

Each group performing environmental data collection activities for the IADN must have written standard operating procedures (SOP) for all important routine program elements including field operations, laboratory operations, and data management. The PI will be responsible for ensuring that all necessary SOPs are developed, and then reviewed and revised on an annual basis. The QAO is responsible for maintaining copies of all SOPs and any changes or revisions to them as part of the QA documentation archive, and for distribution of copies to the IADN QAM and Database Manager. See Appendices J and K for SOP development guidelines and a list of field and laboratory SOPs from groups participating in IADN.

4.4 DATA MANAGEMENT

4.4.1 Interim Data Control Procedures

Until the primary IADN database is operational, two interim IADN data managers (one Canadian, one American) shall be designated to serve as temporary keepers of the official data sets. All agencies participating in the IADN shall submit their available quality assured data to the appropriate interim data manager in a compatible format every six months.

4.4.2 Overall IADN Database Design

The overall IADN data management structure is shown in Figure 4-1. Each country is to have its own national IADN database. Each of these databases will be responsible for merging the data submitted by the IADN participants from their nation and submitting the merged dataset to the IADN central database. The central database will then merge the national datasets, and distribute the complete, binational dataset back to the national databases. A single database manager will be responsible for maintaining the central IADN database.

Figure 4-2 shows the elements that are to make up the central IADN database. The database is to consist of four major sections, the network information system, the site information system, the IADN concentration data files, and statistical data files. The network information system will contain information on the IADN as a whole, including the number and types of sites, the pollutants being monitored, etc. The site information system will contain a detailed description of each IADN site, including location information, an assessment of compliance with siting criteria, a list of instrumentation, etc. The IADN data files will contain several types of files: active samples, blank samples, blank corrected concentrations, and QC data. The statistical data files will contain the results of statistical analyses performed on IADN data by the DBM and others.

Several important factors must be considered in the design of the central database:

Uniformity - The format for all data files must be the same, including the flags and codes used to annotate entries. The first priority of the Database Workgroup is to define a minimum set of flags and codes to be used by all IADN participants.

Storage flexibility - The ultimate goal is for the database to be relational or quasi-relational and allow for changes in format resulting from possible program changes. This is to include the possible addition of new fields due to additions to the list of monitored toxic compounds. In the interim period, existing databases may be adapted.

Input flexibility - The database should accept some variation in input formats. Although standardization of data submission formats is intended, it is unlikely to be complete, and changes may be necessary as additions are made to the list of monitored compounds.

Output flexibility - The database should provide a variety of reporting formats for users, including maps, statistical summaries, and raw data.

All software must be thoroughly tested.

Ideally, read-only online access to the data would be available to the public. Because of scarce resources, this may not be possible initially. However, provision must be made for public access to the data once validation and evaluation is complete.

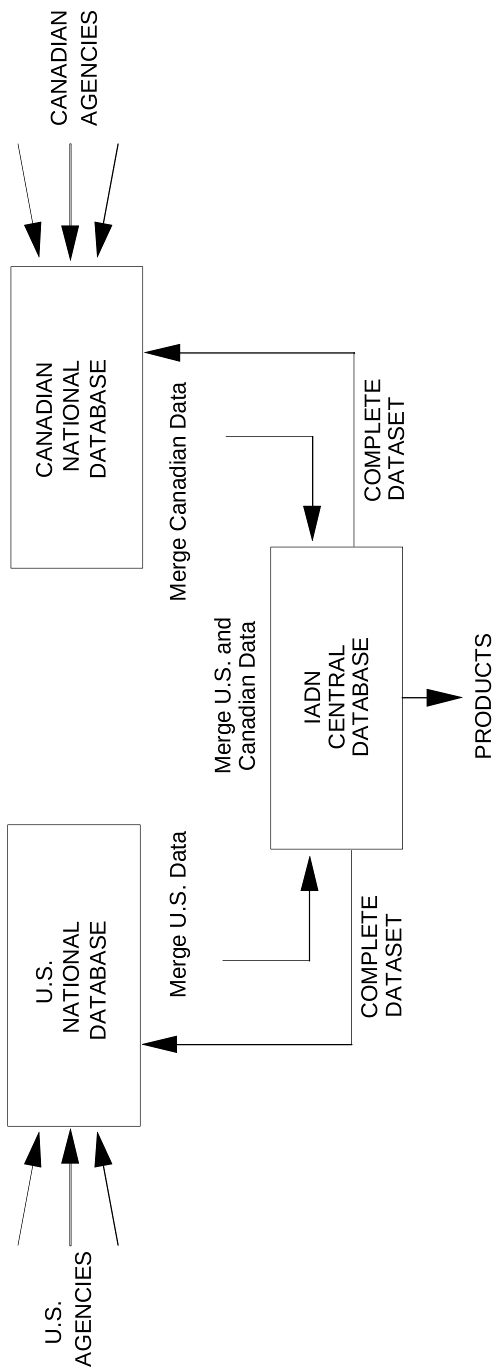

FIGURE 4-1. IADN Data Management Structure

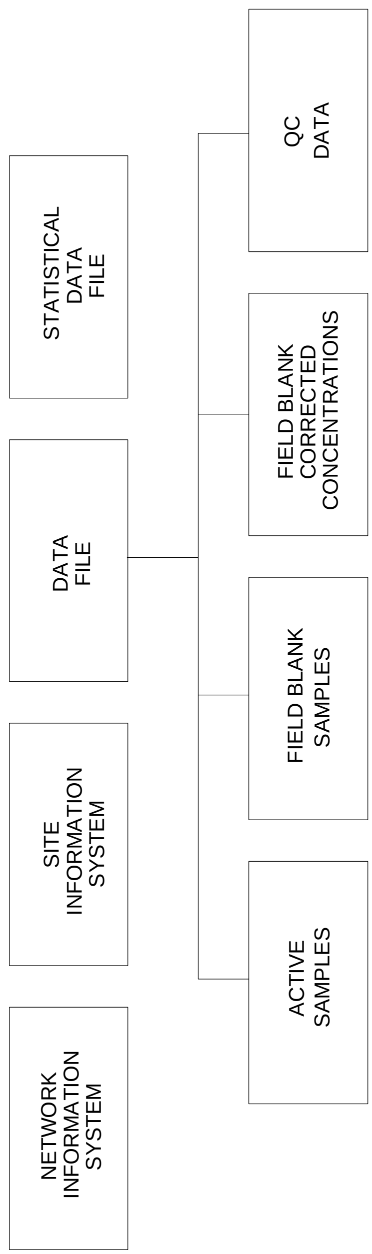

FIGURE 4-2. IADN Central Database Structure

4.4.3 Data Reduction

Ideally, all agencies participating in the IADN should use exactly the same methods to analyze and reduce their data. However, practical and historical constraints may prevent certain laboratories from meeting this ideal. Regardless of this situation, a standard data reduction protocol is necessary to provide comparability of data. The data reduction protocol described in Appendix M has been proposed for use for the IADN. All agencies are to make every effort to conform to it. Any refinements or modifications to the data reduction protocol are to be made by the Operations and Data Management Workgroups and approved by the PMG. All modifications to the data reduction protocol are to be documented.

4.4.4 Data Management Quality Control Procedures

Data Review And Intercomparison

Figures 4-3(a) and (b) are schematic diagrams of the flow of data from collection in the field to entry into the database. Before entry into the database, all data sets must pass several levels of review and intercomparison.

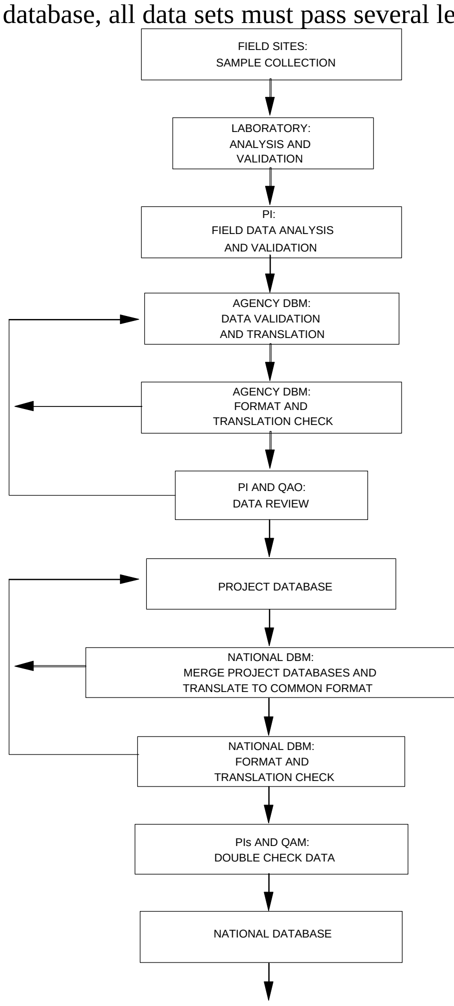

FIGURE 4-3a. IADN Data Flow Field Sites to National Databases

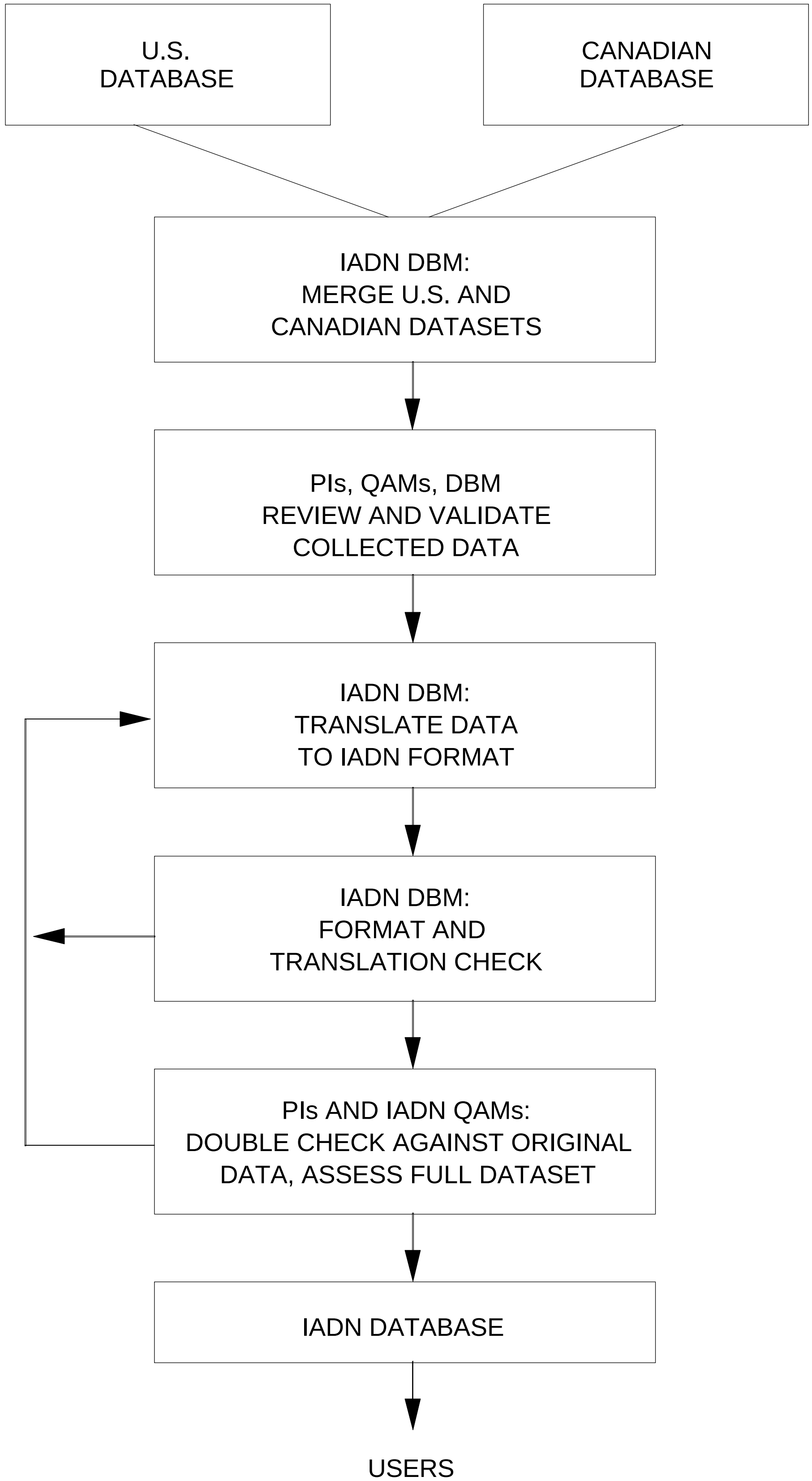

FIGURE 4-3b. IADN Data Flow National Databases to IADN Central Database

The first three levels are performed at the individual agency. First the Principal Investigator (PI) examines the data resulting from laboratory analyses and compares them to documentation from the field sites, checking that all appropriate validation codes have been added and no logistical mistakes have been made (*e.g.*, mislabelled samples, etc.). After the agency DBM has translated the data into the proper format for storage in the agency database, the DBM checks the dataset to ensure proper format and translation. Finally, the PI and the QAO review the data before it is officially entered into the project database.

The project data sets are merged by the national DBMs and then undergo two additional checks before being entered into the national databases. The first is a format and translation check by the National DBM, followed by a review by the PIs and the QA Manager (QAM).

The national data sets are then merged by the IADN DBM, and must undergo three checks before being entered into the IADN central database. The first is an assessment of the complete data set performed semi-annually by the Principal Investigators, along with the QAMs and the DBM (this may be accomplished by teleconference, a physical meeting is not essential). The purposes of this intercomparison are as follows:

Identify anomalies in the datasets (*i.e.*, numbers from one site that are significantly out of line with the others)
Compare the precision of different networks within IADN
Assess the precision of collocated samplers
Assess effects of differences in sampling and analysis among networks
Examine data for consistent biases for individual compounds
Compare method detection limits of different networks
Agree upon representative datasets for each pollutant in each lake

Corrective action should be taken immediately to rectify any problems that are identified. Appropriate corrective actions might include changes to sampling and analysis procedures or to shipping and handling methods for samples.

The next review occurs semi-annually, after the data sets have been received by the DBM, but before they are added to the database. The DBM examines each year's data and makes sure that the proper format has been followed, that no erroneous information has been introduced by the translation process, and that all proper codes and flags have been inserted.

The final check occurs before data are officially entered into the central database. The DBM will send a copy of the dataset to each PI and the IADN QAM who will double-check the final version for discrepancies with the original data.

Corrective Action

If any problems or discrepancies are identified in the review and intercomparison of database entries, the PIs will be responsible for ensuring that proper corrective actions are taken. Corrective actions resulting from data reviews may be placed into two classes.

The first is directed at discrepancies or problems that may be rectified by action within the data management structure. These may be a result of errors in file translation or data entry.

The second category of corrective actions results from problems in the sampling or analytical methodology that are identified by their influence on the dataset. Identifying problems of this type is the primary goal of the semi-annual data comparison meeting of the PIs, QAMs, and DBM. Any data determined to be biased in such a manner should be flagged before being entered into the database. Feedback to the appropriate PIs should occur when a corrective action of this type is implemented.

Data Security

The DBM is responsible for observing and implementing proper security precautions in the operation of the database. Important data security considerations include:

Thorough screening of all data before entry into database
Careful maintenance of backup copies of the database
Only the DBM is to have authorization to write to or change the database

Project and national databases shall have similar requirements for data security.

Audit Trails and Configuration Control

All changes, revisions, or deletions to/from the database are to be recorded. This may be accomplished by use of a chronological "diary" stored in a Lotus spreadsheet (or equivalent). This will be the responsibility of the DBM.

The Data Management Workgroup will be responsible for developing a coding system to differentiate the multiple versions of the data set that will result from revisions, changes, and additions to the database. This system must allow for identification and archiving of every version of the data set that is distributed, as well as keeping records of all the recipients and the version provided to them.

Project and national databases shall have similar requirements for management of internal data records.

4.5 DATA SUBMISSION

Before data are placed in the central database, they must be carefully reviewed. Each agency will be responsible for ensuring that their data meet IADN DQOs (or interim DQI goals until DQOs are implemented). Data that fall short of IADN DQOs or are otherwise judged to be questionable must be annotated with the proper IADN validation flag and an explanation.

4.5.1 Delivery Schedule

The PI from each agency will be responsible for delivery of all available quality assured data to the appropriate national database manager at six month intervals. The data must be in a format compatible with both the national database and the IADN central database, and both hard copy and magnetic media versions must be supplied. All agencies are to provide data with a one-year turn around time.

4.5.2 Format for Data Submission

All agencies that participate in IADN will be required to submit their data to the central database in the format chosen by the Data Management Workgroup. Wherever possible, groups should change their data reporting format to correspond to the standard of the IADN database. This may not be possible because of the differences in analytical techniques and calculation methods used (*e.g.*, different treatments of values below the detection limit, methods for combining results from dual columns). However, every effort should be made to standardize as many aspects of the data management process as possible.

4.6 DATA RETRIEVAL AND REPORTS

It is the responsibility of the DBM, with the assistance of the DB Workgroup, to facilitate user access to the data. Several aspects of this duty include:

Provide standard statistical summaries
Produce interpretive reports, maps, etc.
Format data reports
Provide standard data sets
Provide special reports, as necessary

SECTION 5.0
QUALITY ASSURANCE ASSESSMENT

5.1 DESCRIPTION OF AUDIT PROGRAM

In order to ensure that adequate quality control and quality assurance plans are being fully implemented, each agency participating in the IADN Program should undergo a series of managerial and technical QA audits/reviews at both the program level and the project level. The schedules for audits described in this section are minimum frequencies: individual agencies may have more stringent requirements.

The IADN auditing program will consist of both internal audits (performed within individual agencies) and external audits (arranged by the QAM, and covering the entire IADN) of field, laboratory, and data management procedures. Four specific areas are targeted by the audit program:

Sampling and other field operations
Laboratory operations
Data management and reporting
Program management

The IADN audit program makes use of four types of audits in assessing the quality of the QA programs of the agencies performing data collection and/or analysis for the IADN: Management Systems Reviews (MSR), Performance Evaluations (PE), Technical Systems Audits (TSA), and Audits of Data Quality (ADQ). This section describes these four audit types.

The Management Systems Review (MSR)

The MSR is a tool that management can use to assess the adequacy and effectiveness of the management systems established for a program, project, or process. The MSR does not judge the quality of the data generated by an activity or process under scrutiny. The MSR concentrates on the structures of the quality management systems and the processes by which they are implemented.

Performance Evaluations (PE)

A PE is a quantitative evaluation of a measurement system (including data acquisition and reduction). This evaluation usually involves measuring or analyzing a reference material or test material that is associated with a known value or composition. Usually, the identity of the reference material or test material will be disguised so the operator or analyst will treat it no differently from a test program sample.

Technical Systems Audit (TSA)

The TSA is a qualitative on-site evaluation of a measurement system. The objective of the TSA is to assess and document all facilities, equipment, systems, record keeping, data validation, operations, maintenance, calibration procedures, reporting requirements, and procedures. Although the TSA evaluates the technical aspects of a measurement system, it does not provide any quantitative information.

Audits of Data Quality (ADQ)

An ADQ involves assessing the methods used to collect, interpret, and report the information required to characterize data quality. Assessing a data set or a database requires a detailed review of the recording and transfer of raw data; data calculations; documenting procedures; and the selection and discussion of appropriate data-quality indicators (*i.e.*, precision, accuracy, completeness, comparability, and representativeness).

5.1.1 Audit Protocols

Individual audit protocols shall be developed for each activity selected for audit. The audit protocol development guidelines listed in Appendix M were designed to assist this process. The guidelines shall be used (or modified to suit any special circumstances) when planning any of the four audit types described previously. A copy of each approved audit protocol shall be submitted to the IADN QAM for archiving.

5.1.2 Sampling and Field Operations

Internal

The QAO of each agency operating sampling equipment as a part of the IADN shall schedule PEs of their measurement equipment on a quarterly basis. This review is to include calibrations of all instruments that are traceable to reference standards (*i.e.*, flowrates, volumes).

External

The IADN QA Manager, with the assistance of the QA Workgroup, will be responsible for implementing annual TSAs and PEs of each site involved in data collection for the IADN. The QA Workgroup is responsible for scheduling these audits. These audits are to include an assessment of the compliance of each site with the IADN siting criteria. The QA Workgroup is responsible for developing protocols and guidance for use by the teams performing the external audits.

5.1.3 Laboratory Operations

Internal

Each laboratory QC Coordinator will be responsible for internal review of his/her own laboratory, but must provide the results to the QAO of the agency supplying the samples, and to the IADN QAM and QA Workgroup. Performance evaluations of laboratory equipment and techniques are to be performed at least quarterly.

External

The IADN QA Manager, with the assistance of the QA Workgroup, shall arrange for annual TSAs and PEs of all laboratories performing analyses of samples collected by IADN sites. The QA workgroup is also responsible for arranging annual laboratory intercomparisons of all laboratories involved in the IADN. The QA Workgroup is responsible for developing protocols and guidance for use by the teams performing the external audits.

5.1.4 Data Management

Internal

Annually, the QAO shall perform a traceability audit on a limited sample of data points from his/her agency. The traceability audit shall verify, for a limited set of data, that the data in the database accurately represent the results of the data collection process. The data are to be traced from their origin in sampling and field operations, through laboratory analysis and data reduction and validation, to their entry into the agency database.

External

Annually, the IADN QAM shall perform a traceability audit on a limited sample of data points from each agency. The traceability audit shall verify, for a limited set of data, that the data in the database accurately represent the results of the data collection process. The data are to be traced from their origin in sampling and field operations, through laboratory analysis and data reduction and validation, to their entry into the database.

The IADN QAM, with the assistance of the QA workgroup, shall perform a complete ADQ on each agency biennially. The QA Workgroup is responsible for developing protocols and guidance for use by the teams performing the external audits.

5.1.5 Program Management

External

The QAM and QA workgroup shall arrange biennial MSRs for all agencies participating in the network and for the network as a whole. These are to be performed by an independent outside auditor. The QA Workgroup is responsible for developing protocols and guidance for use by the teams performing the external reviews.

5.2 CORRECTIVE ACTION

Each QAPjP or equivalent will include provisions for written requirements establishing and maintaining QA reporting and feedback channels to the appropriate management authority to ensure that early and effective corrective action can be taken when data quality falls below required limits or when a problem is identified by internal procedures or an audit.

Each agency shall implement a system for tracking corrective action requests, and the actions that result from them. Short term corrective actions initiated by the laboratory or field operators or their supervisors (e.g., recalibration of instruments) should be noted in the field logs or laboratory notebooks. Corrective actions resulting from requests by other network personnel or auditors should be documented by corrective action forms that follow the action from request through implementation. The IADN QAM and the QA Workgroup shall also be informed of any major corrective actions taken and of any data loss in excess of the completeness goal.

The need for corrective action shall be minimized through up-front QA planning and management that establish quality control checks on procured items, a program of preventative maintenance, and predetermined warning or control limits for measurement and analytical systems. There shall be a documented record (normally in the QAPjP of each agency) that describes when corrective actions are to be taken and who is responsible for ensuring that the corrective actions were taken and were effective.

5.3 QUALITY ASSURANCE REPORTING

5.3.1 Audit Reports

The results from each internal audit arranged by the QAO or laboratory QCC will be described in a brief report distributed to the laboratory director, the PI, the PM, the IADN QAM, and all technical personnel involved in the audit or directly affected by the audit results. The QAO of each agency will also submit an annual audit report to the IADN PMG and the IADN QAM. This report will contain the results of all audits performed each year, as well as a description of any corrective actions performed as a result of the audits. The report shall be submitted within four months of the end of each year.

The results of each external audit shall also be made available to the laboratory director, the PI, the PM of the agency or laboratory being audited, and all technical personnel involved in the audit or directly affected by the audit results. The QA Workgroup will prepare an annual report on the results of the external audit program, and any corrective actions resulting from it. This report will be submitted to the IADN PMG within four months of the end of each year.

5.3.2 Quality Assurance Planning and Reporting

The PI and the QAO of each agency are jointly responsible for preparing an annual QA report and work plan which contains a summary of the QA activities of the preceding year and planned QA activities for the coming year. The QA report will facilitate evaluation of the QA program including its costs and effect on data quality. The QA report is to be submitted to the PM for review within three months of the end of each year. The PM has one month to review the report and request any changes. After review, copies of the report shall be distributed to the IADN QAM and the IADN PMG, and should be available to all network personnel and data users. Additional copies should be placed in the documentation archives maintained by the PI, the IADN QAM, and the DBM. A QA report and work plan shall include the following:

Changes made to QA, sampling, analysis, or data management procedures

Measures of data quality for sampling and laboratory including:
- Data completeness (with explanations for lost data)
- Results of precision and accuracy checks on sampling equipment
- Summary of QC measures including spikes, replicates, blanks, and duplicates
- Results of any special studies

Description of significant QA problems encountered and corrective actions taken

Results of internal and external systems and performance audits

Description of current data including scheduled reports and delivery to database

Report on QA training activities

A plan of QA activities for the coming year

SECTION 6.0
ADDITIONAL QUALITY ASSURANCE MATTERS

6.1 NON-ROUTINE SPECIAL STUDIES

Research activities are an important part of the Annex 15 program. Research studies are also essential to the further development of the IADN program. By their nature, research projects and other special studies are often of relatively short duration and small scope. Developing a full QA program with complete documentation for each special study would consume disproportionate amounts of time and resources. However, an adequate level of quality assurance is necessary.

6.1.1 Quality Assurance Requirements

Special studies related to the IADN program may be placed into one of three categories, each requiring a different level of quality assurance:

1. Projects which support Annex 15 of the GLWQA, but are not directly IADN-related (*e.g.*, studies related to other terms of the loading equation or assessments of physical constants used in the loading equation) must be covered by a quality assurance plan or QA narrative statement, but are not subject to this QAPP.

2. Quality control studies and methodology assessments within the IADN (*e.g.*, interlaboratory comparisons, sampling comparisons) may have a direct effect on IADN methods and are therefore subject to the requirements of this QAPP.

3. Special projects which generate concentration data that are to be entered into the IADN database are subject to the requirements of this QAPP, and must also be covered by the QAPjP (or equivalent) of the agency performing the study.

6.1.2 Reporting Requirements for Special Studies

The PI and the QAO of each agency share the responsibility for producing a brief annual report on the results and QA status of all type 2 and 3 special projects (as described in section 6.1.1). The report must contain a summary of QA activities during the previous year and planned QA activities for the coming year for each special project. This report may be included as part of the agency's annual QA report and work plan, or it may be a separate document.

6.2 TRAINING

In order to promote acceptable data quality and ensure proper site operations, a solid training program is necessary. The purpose of a training program is to ensure consistency among the various sampling sites and avoid sample contamination. The QAO will ensure that the following specific QA goals of the training program have been met:

Distribuion of current SOPs and technical manuals to all personnel

Ensure that all personnel are familiar with any procedural changes, including annual reviews

Ensure that all site operators are completely familiar with all aspects of site operation, including:
- Equipment operation
- Changeover and shipping procedures
- Sample documentation procedures
- Equipment maintenance
- Health and safety procedures

Ensure that all personnel have basic knowledge of the goals and operations of the IADN

The Laboratory QCCs will be responsible for confirming that training of laboratory personnel has taken place and that periodic reviews occur. Specific goals of the laboratory training program are similar to those listed previously for field personnel, with the additional requirement that all laboratory personnel be experienced with the lab equipment that they will be responsible for operating (*e.g.*, GC/MS, GC/ECD, etc.).

Before implementing new operational procedures and updates to SOPs and technical manuals, each monitoring group shall take steps to ensure that all staff are made aware of the changes and their implementation. After the changes have taken effect, the agency QAO shall ensure that they have been properly implemented.

The responsibility for identifying technical and QA/QC training needs within the IADN Program is shared by the QAM and the QA Workgroup. Technical and nontechnical personnel should be afforded the opportunity to enhance their skills and capabilities by attending training courses, workshops, meetings, and seminars as permitted within the constraints of the IADN program budget and schedule.

6.3 DOCUMENTATION AND DOCUMENT CONTROL

6.3.1 Documentation Archives

The QAO for each agency is responsible for maintaining an up-to-date archive of electronic and physical copies of all QA documentation, including QAPPs, QAPjPs, field and laboratory SOPs, audit protocols and procedures, and audit reports for the duration of the IADN program. The QAO shall also record any changes or revisions that have been made to these documents. A chronological "diary" of revisions stored in a Lotus spreadsheet (or equivalent) may be used. The PI and laboratory QCC will be responsible for helping the QAO keep the archives up to date. The QAO shall notify the IADN QAM of any changes/revisions annually and supply updates of the chronological "diary" on a quarterly basis. This information is to be included in the agency annual report.

The IADN QAM is responsible for maintaining a central IADN documentation archive, which shall be kept by the IADN database manager(s) as an adjunct to the central database(s). This archive shall contain physical copies of all QA documents from the individual data collection agency's files (QAPPs, QAPjPs, field and laboratory SOPs, audit protocols and procedures, audit reports, and records of revisions and changes to QA documents). The central documentation archive shall be updated annually. The central collection of chronological "diary" files shall be reviewed quarterly by the QAM.

6.3.2 Documentation for Field Sites and Laboratories

Each field site operator shall maintain a logbook which contains a record of all samples submitted, any sampling or instrumental problems encountered, corrective actions taken, calibrations of instruments, and preventive maintenance. Similar logbooks shall be maintained by laboratory analysts, containing records of all analyses performed, records of all samples received, calibrations and preventive maintenance, and notes of any problems encountered.

The PI shall be responsible for development of a Site Operator's Manual, which shall contain descriptions of all sampling equipment; instructions for operation and maintenance, including SOPs and procedures for troubleshooting and corrective actions; and QA procedures. The PI shall also develop a Technical Manual containing detailed descriptions of site instrumentation, with schematic diagrams, manufacturer's instructions, and procedures for materials procurement, inventory control, preventative maintenance, and corrective actions.

The Laboratory QCC shall be responsible for development of a Laboratory Operations Manual, containing analytical SOPs, sample handling procedures, corrective actions, and QA/QC procedures.

6.3.3 Document Pagination

Documentation is necessary for the proper operation of the network and must be properly produced, updated, and distributed on a regular basis. A document cataloguing system which lists document type, identification number, title, author(s), date of publication, dates of revisions, and a user distribution list is to be maintained by each QAO as part of the document archive. The IADN QAM is to maintain a similar catalogue as a part of the central IADN document archive.

All pages are to be indexed in the following form:

IADN QAPP
Section: 3
Revision: 1
Date: 4/7/92
Page: 2 of 5

This system allows for easy insertion of revised, updated, or additional pages into existing documents. Each major section should begin on a new page so that the revision of single sections can be done without affecting other sections.

When pages are revised, they are to replace the old pages and a notation is to be made in the table of contents and in the chronological "diary" files of the PI, QAO and QAM.

Documents subject to these requirements include QAPPs, QAPjPs and field and laboratory SOPs.

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APPENDIX A - GLOSSARY

IADN QAPP GLOSSARY

Accuracy - the closeness of agreement between an observed value and an accepted value. Accuracy includes a combination of random and systematic error or bias components.

Arithmetic Mean - the most commonly used measure of central tendency, commonly called the "average." Mathematically, it is the sum of all the values of a set divided by the number of values in the set.

Bias - a constant or systematic error frequently present in test work. It differs from random error and manifests itself as a persistent positive or negative deviation from the known or true value.

Blank - an artificial or clean "sample" designed to monitor the introduction of artifacts into the measurement process. The blank is taken through all appropriate steps of the process.

Blind Sample - a sample submitted for analysis whose composition is known to the submitter but unknown to the analyst. A blind sample is one way to test proficiency of a measurement process.

Calibration Standards - a gaseous or liquid mixture prepared from the primary dilution standard and stock standards of the internal reference and surrogate analytes. The mixtures are used to calibrate the instrument and record the detection of the analyte concentration.

Calibration - a comparison of a measurement standard or instrument with another standard or instrument to report or eliminate by adjustment any variation (deviation) in the accuracy of the item being compared. The concentration levels of the calibration standards should bracket the range of concentrations for which actual quantifiable test results are expected.

Chain-of-Custody - a procedure for preserving the integrity of a sample or of data. (e.g., a written record listing the location of the sample/data at all times).

Coefficient of Variation - a measure of relative dispersion (precision). It is equal to the standard deviation divided by the mean, multiplied by 100, and expressed as a percentage value.

Collocated Samples - independent samples collected in such a manner that they are equally representative of the parameters of interest at a given point in space and time.

Comparability - a measure of the confidence with which one data set can be compared to another.

Completeness - the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal operations, usually expressed as a percentage.

Confidence Level - the chance or probability, usually expressed as a percentage, that a confidence interval will include a specific population parameter. The confidence levels usually associated with confidence intervals are 90, 95, and 99 percent.

Congener - A chemical substance that is related to another substance, such as a derivative of a compound or an element belonging to the same family as another element in the periodic table.

Correlation Coefficient - a number between -1 and +1 that indicates the degree of linearity between two sets of numbers. The closer to -1 or +1, the stronger the linear relationship between the sets (i.e., the better the correlation). Values close to zero suggest no correlation between the sets (i.e., independence is indicated).

CV - see "Coefficient of Variation."

Data Quality - the totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Data Quality Indicator (DQI) - Statements of data quality commonly used to express measurement uncertainty as precision, accuracy, representativeness, completeness and comparability. DQIs may or may not correspond to DQOs.

Data Quality Objectives (DQO) - Qualitative and quantitative statements of the quality of data needed from a particular data collection activity to support a specific decision, regulatory action, or program.

Data Reduction - the process of transforming raw data by the use of calculations, standard curves, concentration factors, etc., and collating them into a form more easily used by the data user.

Data Validation - a systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use.

Degrees of Freedom - the divisor used in the calculation of a variance term; in the simplest cases it is one less than the number of results.

Detection Limit - the smallest concentration/amount of the component or analyte of interest that can be measured by a single measurement with a stated level of confidence.

Duplicate Measurement - a second measurement made on the same (or identical) sample of material to assist in the evaluation of measurement variance.

Duplicate Sample - a sample that has been divided (in the field, in the preparation lab, or prior to analysis) with both aliquots carried through all steps of processing in an identical manner. (See "replicate sample" and "split sample.")

Equipment Blanks - clean "samples" which are opened in the field and the contents brought into contact with the sample collection device, collected in a sample container, and returned to the laboratory as a sample. Equipment blanks are used to check on sampling device cleanliness. (See also "field blank.")

Field Blank - a clean "sample" that has not been exposed to the sample stream but has been carried to the sampling site and exposed to sampling conditions (bottle caps removed, preservatives added), sample preparation (reagents), and the measurement system. (See also "equipment blank.")

Geometric Mean - measure of the most representative location parameter for a log-normal distribution of data. Mathematically calculated as the nth root of the product of n values, or by transforming the data to the logarithm, calculating the average of the transformed data, and then taking the antilog.

Geometric Standard Deviation - measure of the dispersion for a log-normal distribution of data. Mathematically calculated as the antilog of the standard deviation of the logarithms of the measurements.

Isomer - One of two or more chemical substances having the same elementary percentage composition and molecular weight but differing in molecular structure, and therefore in properties; there are many ways in which such structural differences occur; one example is provided by the compounds isobutane, $CH_3CH(CH_3)_2$, and *n*-butane, $CH_3(CH_2)_2CH_3$.

Instrument Detection Limit (IDL) - The minimum level or concentration of the analyte which can be observed by the instrument and which is statistically different from the response obtained from background instrumental noise. For an IADN official definition of IDL, see Section 3.3.1 of Appendix I.

Laboratory Blank (LB) - A blank sample used as a baseline for the point of comparison. For example, a blank is processed and prepared for analyses along with field samples, and used to adjust or correct routine analytical results.

Laboratory Matrix Blank (LMB) - A clean, unused sampling matrix (filter, XAD resin, etc.) which is processed through the preparation and analytical method to establish baseline concentrations in the sampling media and identify any artifacts.

Laboratory Matrix Sample (LMS) - A combined spike of known quantities of multiple analytes which is added to a blank sampling matrix (filter, XAD resin, etc.) and processed through the preparation and analytical method. Laboratory matrix samples are processed periodically to provide recovery data for assessment of laboratory accuracy and precision.

Laboratory Surrogate Spike (LSS) - A known quantity of a compound or target analyte which is added to the sample being analyzed to provide recovery data for assessing laboratory accuracy and precision.

Limit of Detection (LOD) - The minimum level or concentration of the analyte which can be observed by the instrument and distinguished from instrument noise with a specified degree of probability, calculated from field blanks. For an IADN official definition of LOD, see Section 3.3.3 of Appendix I.

Method Detection Limit (MDL) - The lowest concentration of analyte in distilled water or applicable solvent that a method can detect reliably and that is statistically different from a blank carried through the complete method, including extraction and pretreatment of the sample. For an IADN official definition of MDL, see Section 3.3.2 of Appendix I.

Minimum Detectable Level - see "method detection limit."

Noise - the random errors of observation and other uncontrollable effects which are irrelevant to the purpose of the measurements.

Outlier - a value which appears to deviate markedly from other members of the sample in which it occurs.

Performance Audit - an audit in which quantitative data are independently obtained for comparison with routinely obtained data in a measurement system to evaluate the proficiency of an analyst or laboratory.

Polychlorinated Biphenyl (PCB) - One of several aromatic compounds containing two benzene nuclei with two or more substituent chlorine atoms. They are highly toxic colourless liquids with sp. gr. of 1.4 to 1.5. Because of their persistence and contribution to ecological damage from water pollution their manufacture was discontinued in the U.S in 1976.

Polycyclic Aromatic Hydrocarbon (PAH) **-** One of several aromatic compounds composed of two or more benzene rings (*e.g.*, naphthalene, anthracene). Some PAHs are highly carcinogenic (*e.g.*, benzo[a]pyrene). PAHs are also known as Polynuclear Aromatic Hydrocarbons or Polycyclic Organic Matter.

Precision **-** the degree of mutual agreement among individual measurements of the same property, usually obtained under similar conditions. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

Preventive Maintenance **-** an orderly program of positive actions for preventing failure of equipment and ensuring, insofar as possible, that the equipment is operating with the reliability required for the production of quality results.

Primary Reference Standard **-** a homogeneous material with specific properties, such as identity, purity, and potency, that has been measured and certified by a qualified and recognized organization.

Primary Standard **-** a substance or device, the value of which can be accepted (within specific limits) without question when used to establish the value of the same or related property of another material.

Protocol **-** a highly detailed written procedure to be used when performing a measurement or related operation.

Quality **-** the totality of features and characteristics of a product or service that bear on its ability to satisfy given needs.

Quality Assessment **-** the overall system of activities whose purpose is to provide assurance that the quality control activities are applied effectively. It involves a continuing evaluation of performance of the production system and the quality of the products produced.

Quality Assurance **-** an integrated system of activities in the area of quality planning, quality control, quality assessment and quality improvement to provide to the producer or user of a product or service the assurance that it meets defined standards of quality.

Quality Assurance Program Plan **-** a formal document which describes an orderly assembly of management policies, objectives, principles, organizational responsibilities, and procedures by which an agency or laboratory specifies how it intends to a) produce data of documented quality to meet the user's needs, and b) provide for the preparation of Data Quality Objectives, Quality Assurance Projects Plans, and Standard Operating Procedures.

Quality Assurance Project Plan - an orderly assembly of detailed and specific procedures by which an organization or laboratory delineates how it produces data of the quality required by the data user for a specific project.

Quality Control - the overall system of activities whose purpose is to control the quality of a product or service so that it meets the needs of users. The aim is to provide quality that is satisfactory, adequate, dependable, and economic.

Random Error - that portion of the variance in repeated measurements that is random in nature and individually not predictable. The causes of random error are assumed to be indeterminate and/or unassignable. The distribution of random error is generally assumed to be normal (i.e., Gaussian).

Raw Data - any laboratory worksheets, records, memoranda, notes, or exact copies thereof, that are the results of original observations and activities of a measurement or study and are necessary for the reconstruction and evaluation of the report of that study. In the event that exact transcripts of data have been prepared (e.g., tapes which have been transcribed verbatim, dated, and verified accurate by signature), the exact copy or exact transcript may be substituted. Raw data may include photographs, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments.

Recovery - the fraction of analytes or materials of interest recovered by an analytical method from a sample containing a known amount of the materials of interest.

Reference Material (RM) - a material or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for the assignment of values to materials.

Reference Method - a sampling and/or measurement method which has been officially specified by an organization as meeting its data quality requirements.

Reference Standard - material incorporating analyte(s) of interest having known concentration(s) and purity. Such materials are used to calibrate the measurement system or verify that the initial standard curve is in effect (i.e., no instrument drift, plugging of critical orifices, etc., has occurred).

Relative Standard Deviation **-** see "coefficient of variation."

Replicability **-** the precision, usually expressed as a standard deviation, measuring the variability among replicates.

Replicate Sample **-** two or more samples taken from the same source at the same time and processed (handled or analyzed) under identical conditions.

Representativeness **-** the degree to which data accurately and precisely represent a characteristic of a population.

Sample Custody **-** a defined procedure for establishing, verifying, and documenting the security, handling, and processing of samples and/or data from the time of sample collection through data processing and reporting.

Spike **-** a known mass added for the purpose of determining recovery, or for quality control.

Split Sample **-** a sample which has been divided into aliquots and processed by a different analyst.

Standard Deviation **-** the most common measure of the dispersion of observed values or results expressed as the positive square root of the variance.

Standard Materials **-** individuals or mixtures of target parameters of known concentrations and purities that are used for standardization of the measurement system. These are preferably highly purified reagents or samples traceable to a certifying organization.

Standard Method **-** a method or procedure on consensus opinion or other criteria and often evaluated for its reliability by collaborative testing and has organizational approval.

Standard Operating Procedure (SOP) **-** a written document which details an operation, analysis or action whose mechanisms are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

Standard Reference Material (SRM) **-** a material produced in quantity, of which certain properties have been certified by the National Institute of Standards and Technology (NIST) or other agencies to the extent possible to satisfy its intended use.

Surrogate - a pure substance to be added to environmental samples for quality control purposes which is not likely to be found in an environmental sample but which mimics the analyte of interest.

System Audit - a systematic on-site qualitative review of facilities, equipment, training, procedures, record keeping, data validation, data management, and reporting aspects of a total (QA) system, a) to arrive at a measure of capability of the measurement system to generate data of the required quality, and/or b) to determine the extent of compliance of an operational QA system to the approved QA project plan.

Traceability - the ability to trace the source of authenticity and/or uncertainty of a measurement, a measured value, a document, or a working standard.

Uncertainty - an indication of the variability associated with a measured value that takes into account two major components of error; bias, and the random error attributed to the imprecision of the measurement process.

Validation - the process by which a sample, measurement method, or a piece of data is deemed useful for a specified purpose.

Variance (as defined mathematically) - a measure of dispersion; it is the sum of the squares of the difference between the individual values of a set and the arithmetic mean of the set, divided by one less than the number of values.

APPENDIX B - IADN IMPLEMENTATION PLAN

APPENDIX C - MASS LOADING MODEL EQUATIONS

THE IADN MASS BALANCE MODEL

The scientific community has generally agreed to use a mass balance approach to model the loading of pollutants to the Great Lakes. Figure C-1 shows the major elements of a total mass balance on pollutants in the Lakes.

The IADN study is concerned with pollutant loading by atmospheric pathways. For the purposes of the IADN, a more specialized equation has been derived, which models only the atmospheric component of mass loadings to the Great Lakes.

The equation to be used within the IADN program for modelling the atmospheric component of mass loadings is as follows:

$$L = L_t + P + G + D + RS + F$$

Where:

L = Total atmospheric loading as g y^{-1}

L_t = Atmospheric component of tributary loading to lake

$$F_t C_t \; {}_t$$

P = Precipitation component of loading to lake

$$C_p R_p A_p$$

G = Net gas phase transfer component of loading to lake

$$A K_{ol} [(1 \quad {}_a) C_a \frac{RT}{H} \quad (1 \quad {}_w) C_w]$$

D = Dry deposition of particulates to lake

$${}_a A \, C_a V_d$$

RS = Resuspension of particles from lake into air

$${}_w C_w F_r$$

F = Fog component of loading to lake (equation not currently available)

With:

A = Area of lake (m^2)

A_p = Area of lake covered by precipitation (m^2)

C_a = Concentration in air ($ng\ m^{-3}$)

C_p = Concentration in precipitation ($\mu g\ l^{-1}$)

C_t = Concentration in tributary ($\mu g\ l^{-1}$)

C_w = Concentration in water ($\mu g\ l^{-1}$)

F_r = Resuspension flux function ($m^3\ yr^{-1}$)
(Not currently available in functional form)

F_t = Tributary flow ($m^3\ yr^{-1}$)

H = Henry's law constant ($Pa\ m^3\ mol^{-1}$)

K_{ol} = Air-water mass transfer coefficient ($m\ yr^{-1}$)

R = Gas constant ($Pa\ m^3\ mol^{-1}\ K^{-1}$)

R_p = Rate of precipitation ($m\ yr^{-1}$)

T = Ambient temperature (K)

V_d = Particulate deposition velocity ($m\ yr^{-1}$)

$_a$ = Particulate fraction of concentration in air

$_t$ = Fraction of tributary loading which is atmospheric in nature

$_w$ = Particulate fraction of the concentration in water

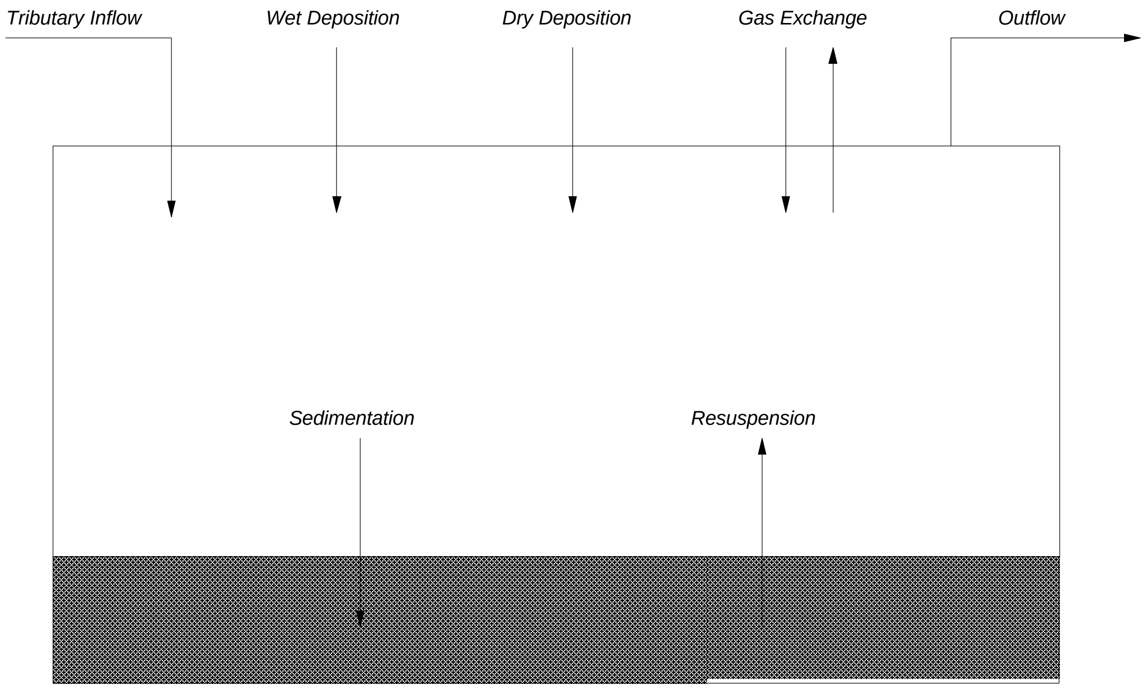

Figure C-1. Elements of the Mass Balance

APPENDIX D - IADN SITING CRITERIA

APPENDIX E - ANNUAL IADN TIMETABLE

IADN Annual Timetable

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PI/QAO: notify IADN QAM of any documentation changes or revisions		PI/QAO: submit annual QA report and workplan*	QAO's: submit annual agency audit report		PI's: submit available QA'd data (Jun. 30)						PI's: submit available QA'd data (Dec. 31)
IADN QAM: update central documentation archive		PI's: submit updated "diary" files	QA WG: submit annual external audit report		PI's: submit updated "diary" files			PI's: submit updated "diary" files			PI's: submit updated "diary" files
		IADN QAM: Review "diary" files	PM's: submit comments on annual QA report and workplan		IADN QAM: Review "diary" files			IADN QAM: Review "diary" files			IADN QAM: Review "diary" files

<u>Quarterly</u>

QAO's:
Performance Evaluations of measurement equipment at each site

Lab QCC's:
Performance Evaluations of each laboratory

<u>Annually</u>

IADN QAM:
Technical Systems Audit and Performance Evaluation of each site

IADN QAM:
Technical Systems Audit and Performance Evaluation of each laboratory

IADN QAM:
Traceability audit of representative data sample for each agency

* QA Annual Report and Workplan for all type 2 and 3 special studies must either be included in overall QAARW or as a separate report

<u>Biennially</u>

IADN QAM:
Management Systems Review of agencies and entire network

APPENDIX F - ORGANIZATIONAL CHARTS FOR IADN PARTICIPANTS

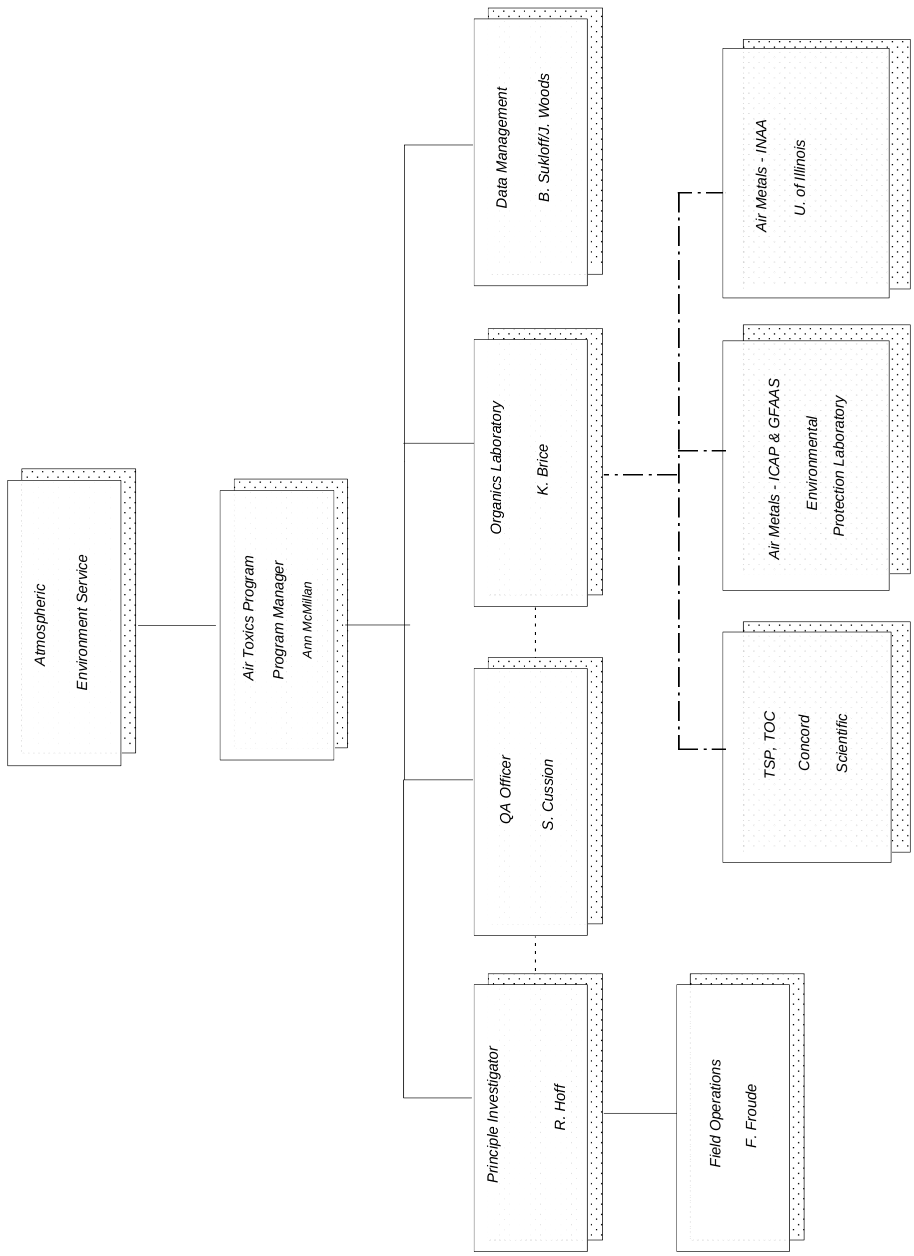

Figure F-1. Organization of AES for IADN

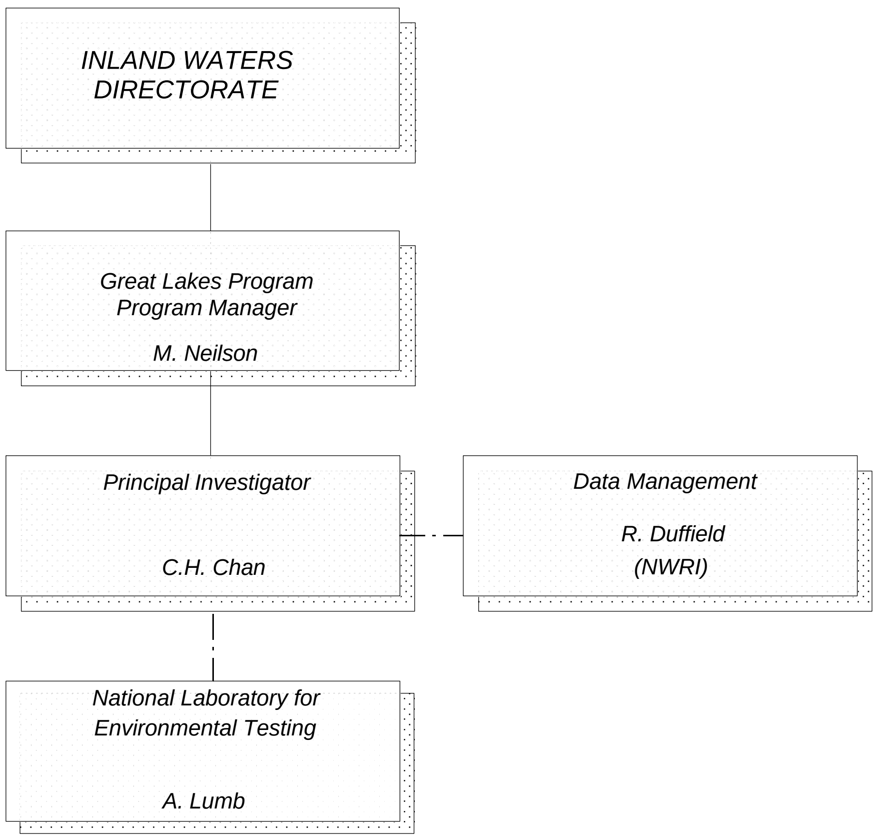

Figure F-2. Organization of IWD for IADN.

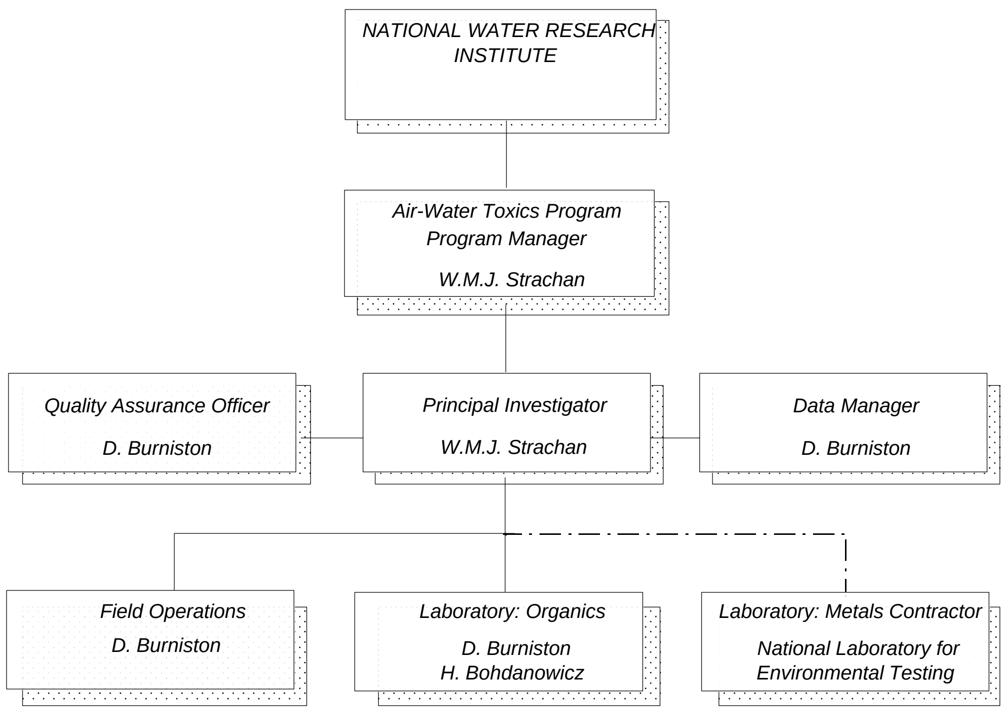

Figure F-3. Organization of NWRI for IADN.

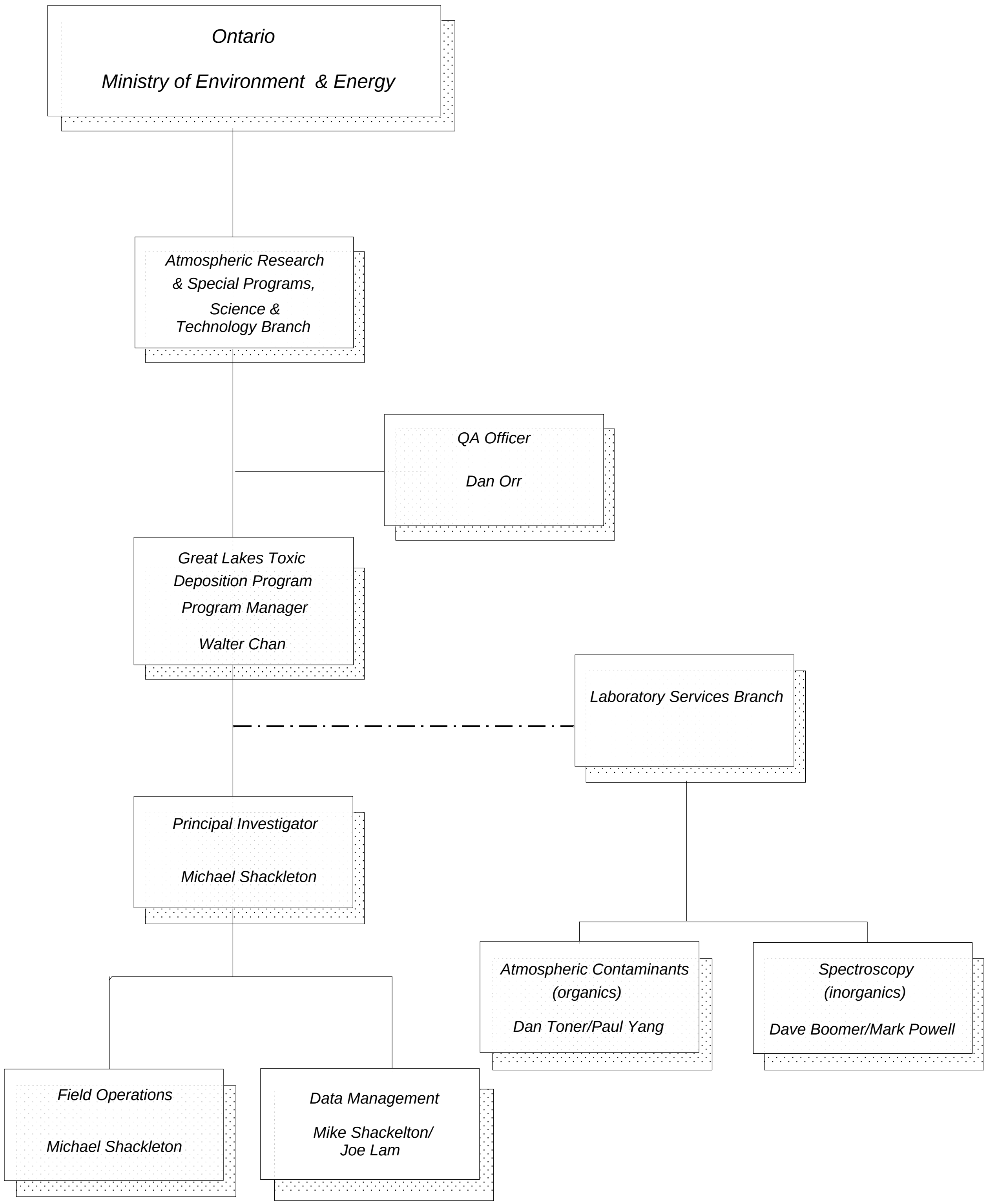

Figure F-4. Organization of MOEE for IADN.

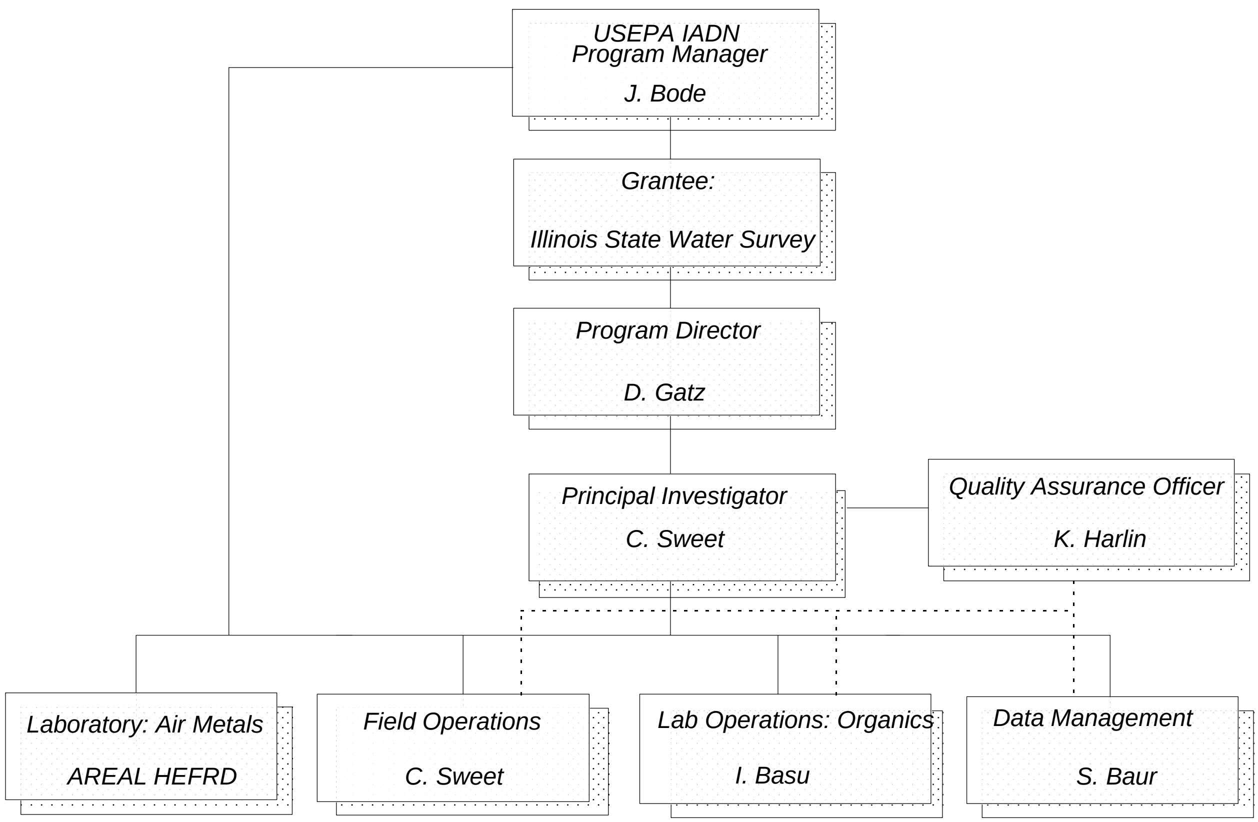

Figure F-5. Organization of USEPA and ISWS for IADN.

APPENDIX G - MEMBERSHIP OF BINATIONAL WORKGROUPS

This Appendix contains the current membership roll of the binational workgroups, with their correct addresses and phone/FAX numbers. This list will be updated annually. If any ad-hoc workgroups have been created, their purpose and membership should also be noted in this appendix.

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APPENDIX H - GUIDELINES FOR CONTENTS OF QUALITY ASSURANCE PROJECT PLANS

Section 4.2 of this QAPP lists the required elements of QAPjPs for IADN participants. This Appendix contains discussions of each of these elements. There are several groups participating in the IADN program, and each has its own QAPjP (or equivalent). Because this QAPP is the only program-wide QA document for the IADN, it is necessary to include a certain level of detail on the following subjects in order to promote consistency of QAPjPs and operational methods among IADN participants. Where applicable material is included in the body of this QAPP, it has been referenced. In other cases, additional detail on QA requirements has been included within this Appendix.

Project Description

This section of a QAPjP should be a brief description of the overall project, especially the monitoring activities covered by the QAPjP, including the type of samplers to be used, the approximate number of monitoring stations, and the goals of the project. See Section 1.3 of this QAPP for a description of the IADN as a whole.

Project Organization and Responsibility

This section should contain a brief outline of the responsibilities of any personnel not included in the QAPP, and a chart of the project organization. Section 3.1 of this QAPP contains an organizational chart for the IADN showing the participating agencies and their relationships to one another. Appendix F contains organizational charts for the individual agencies that perform data collection as a part of the IADN. Section 3.2 describes the responsibilities of these agencies with respect to the IADN and Annex 15 of the GLWQA, and Section 3.3 describes the organization and responsibilities of the international workgroups that have been created to address issues affecting all IADN participants. Section 3.4 details the responsibilities of specific IADN personnel.

Data Quality Objectives (DQOs) for Measurement Data

This section should contain clear statements of the specifications that measurements must meet to achieve project objectives. This should include quantitative goals for data quality measures (*e.g.*, precision, accuracy, completeness) that may be used to determine the acceptability of data. Qualitative goals should be stated for parameters that are not quantifiable (e.g., representativeness, comparability). DQOs for the IADN are discussed in Section 4.1 and Appendix I of this QAPP.

Sampling Procedures and Siting Criteria

This section must include or reference detailed SOPs for field sampling operations and the criteria that are used to choose sites for monitoring stations. Detailed descriptions of each site should be included, with latitudes and longitudes, and a location map for each site. Appendix D of this QAPP contains the IADN siting criteria. Section 4.3 of this QAPP addresses SOP requirements for IADN participants.

Sample Custody

This section will describe the methods used to keep a record of all the steps of a sample's progress, including collection, labelling, handling, transport, and laboratory analysis. The section should also include copies of all sample tracking forms, etc.

Sample Tracking Procedures **-** Formal chain-of-custody procedures are not a requirement. However, a unique sample i.d. shall be assigned at collection, and this i.d. must be carried through to data tabulation. A record must be kept of all the steps of a sample's progress through the system, including collection, labelling, handling, transport, and laboratory analysis. The sample tracking codes are to be included in the database in a manner which facilitates tracking the origin of all data. Copies of all sample tracking forms are to be maintained in each agency's central documentation archive.

Calibration Procedures

This section should describe or reference calibration procedures for all field and laboratory instruments used in the project. Each description should contain specific calibration procedures, including details of calibration standards and traceability, and calibration schedules.

Analytical Procedures

This section should include or reference detailed SOPs for all analytical procedures, including sample preparation and cleanup. If standard materials are available, they may be referenced. Nonstandard methods must be described in detail, either in the QAPjP, or in separate standard operating procedures. Section 4.3 of this QAPP addresses SOP requirements for IADN participants.

Procurement of Materials and Equipment **-** Care must be taken to ensure that no error is introduced to the data as a result of variability in the quality of materials used in the data collection process. All media used in sampling and analysis (*e.g.*, filters, resins, etc.) shall be of certified quality, with random samples from each lot tested for purity and absence of contaminants prior to their use in the lab or field. The sources of all materials shall be documented, with a record kept of the receipt of each lot and the samples for which it was used. All QA/QC materials (*i.e.*, reference standards) must be certified, and records of their origin and use must be maintained. All instruments or equipment must be tested to ensure proper operation and compliance with specifications prior to use.

Data Reduction, Validation, and Reporting

This section should describe the procedures used to manage the data produced by the project. Details should be provided of the methods and equations used to reduce the raw data to useable form, including treatment of blanks. Data validation procedures should also be described, including detailed lists of all comment codes and validation flags used to annotate data. Data reporting should also be covered, with descriptions of the reporting format and units, and a list of all deliverables required of the analytical laboratory. These topics are discussed in Sections 4.4, 4.5, and 4.6 of this QAPP.

Internal Quality Control Checks

This section contains descriptions of all QC checks that are used throughout the project, including field and laboratory activities. This should include details of split or replicate samples, spikes, blanks, and any other techniques used to evaluate the analytical methods.

Laboratory Quality Control Checks **-** Quality control for analytical procedures shall be provided by a regular schedule of laboratory quality control checks. These shall include control checks to quantify the variability of the results in terms of precision and accuracy, and recognize out-of-control conditions as they develop. These QC checks are to be described in detail in the SOPs for each laboratory and shall include the following:

Regular instrument calibrations

Analysis of control samples for instrument drift and analytical precision and recovery

Analysis of QC samples: evaluation of precision, accuracy, and bias by analysis of spiked samples, surrogate recovery, laboratory blanks, and duplicate samples

Maintenance of QC documentation: control charts, MDL, statistics, and control limits

Assessment of comparability through interlaboratory comparisons of spiked samples

Preliminary data validation and screening in order to flag data records from: damaged or contaminated samples, samples with insufficient documentation, samples containing concentrations which exceed expected levels by statistically significant margins, and samples analyzed without proper QC procedures

Any analysis resulting in questionable results shall be repeated, if possible, or flagged if reanalysis is not feasible. If the results of any QC check do not meet the acceptance criteria set in the laboratory SOPs, the analytical results shall be flagged back to the last run for which all QC checks were acceptable.

Field Quality Control Procedures **-** Quality control procedures for field operations shall be performed on a regular basis. Field QC is to be described in detail in SOPs for field operations or technical/operator manuals. Important field QC procedures include:

Flow rate calibrations for air samplers

Calibration of scales used to weigh precipitation samples

Traceability of all calibration standards to primary reference standards

Visual checks on meteorological equipment

Performance and System Audits

This section should describe the QA audits to be used to assess the operation of the project. A schedule should be included, along with a description of each type of audit that is planned. Reporting requirements should also be given. IADN auditing requirements are addressed in Section 5.1 of this QAPP, with audit reporting requirements in

Section 5.3.1.

Preventive Maintenance

This section should contain a summary of the preventative maintenance procedures to be used for both field and laboratory equipment, including a performance schedule.

Specific Routine Procedures to Assess Data Quality Indicators:
Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC)

This section should contain detailed descriptions of the methods used to calculate and assess data quality indicators. Equations should be included for precision, accuracy, completeness, and method detection limit. This section should complement the section on data quality objectives, providing the means for assessing whether or not data meet the DQOs.

Corrective Action

This section should describe the project corrective action system. This should include the criteria which determine when corrective actions are called for, and procedures by which they are to be implemented. Also included should be a corrective action request/tracking form which will follow the request through the system, until the problem is rectified. Corrective actions are addressed in Sections 4.4.4 and 5.3.2 of this QAPP, for corrective actions resulting from data assessments and from audits, respectively.

QA Reports to Management

This section should describe the type and frequency of QA reports to management that are required. The persons responsible for preparing these reports should also be identified. IADN QA reporting requirements are addressed in Section 5.3.2 of this QAPP.

APPENDIX I - INTERIM DATA QUALITY INDICATORS

1.0 INTRODUCTION

Data Quality Objectives (DQOs) are qualitative and quantitative statements of the quality of data needed from a particular data collection activity to support a specific decision, regulatory action, or program. DQOs are the basis for detailed design of data collection and QA/QC activities. The use of DQOs increases the likelihood that data collected will meet the needs of data users. DQOs specify the quality of data needed to meet program goals and are the result of a rigorous and detailed development process. They may be a quantitative statement of what quality data are desired or expected for a measurement parameter in terms of such characteristics as precision, accuracy, or completeness; or they may be a qualitative description of what factors must be considered to properly characterize the parameter in terms of representativeness or comparability.

Data Quality Indicators (DQIs) are statements of data quality commonly used to express measurement uncertainty as precision, accuracy, representativeness, completeness, and comparability. DQIs may be determined as the result of a formal DQO development process or may be based on what is achievable through the current state of the art. It is possible to have DQIs that represent the state of the art that nonetheless do not meet the DQOs required to satisfy program goals. DQIs serve as specifications of the quality of the data, however that quality determination is made.

The IADN measurement data will consist of determinations of the concentration of various toxic chemicals in both air and precipitation. The primary use of the measured concentration data will be to determine the deposition of the toxic chemicals to the Great Lakes in terms of seasonal and annual averages. Deposition estimates are to be derived from the concentration measurements through the use of certain loading equations (see Section 1.3 and Appendix C). These loading equations make use of additional parameters and constants (such as deposition velocity and Henry's Law constant) that have additional uncertainties associated with them.

Ideally, a formal DQO development process would be used to determine what uncertainty is acceptable for estimates of deposition. Part of the process would include a rigorous sensitivity analysis to determine those uncertainties in concentration measurements and those other terms and parameters in the loading equations that would be needed to achieve the desired uncertainty in deposition. These data quality objectives for the concentration measurements and associated parameters (such as temperature and flow) would then become the DQIs for the measurement data.

Participants of the workshop that reviewed initial drafts of this QAPP agreed that for IADN to meet its program goals, the deposition of certain chemicals would need to be determined with an uncertainty of roughly 30 percent. They also agreed that the current state of knowledge and measurement art is such that it is not possible to determine the deposition of many of these chemicals to better than within a factor of two. These same participants also agreed that determining the concentration of specific compounds is subject to an uncertainty of roughly 50 percent for many of the chemicals of interest. Most of the uncertainty in deposition estimates arises from uncertainties in the terms and parameters used in the loading equations. Before significant resources are expended to improve measurement data quality, detailed sensitivity analyses of the loading equations and their parameters should be performed to determine which terms, parameters, and uncertainties have the largest effect on calculations of loadings for specific toxic compounds. The results of the sensitivity analyses should be used to establish research priorities and develop realistic DQOs for IADN. In the meantime, DQIs should be based on the current state of the art for measuring the concentration of the specific toxic compounds.

In Section 2.0, this appendix provides information that may be used to develop DQOs for IADN concentration measurements. In addition, Section 3.0 establishes interim DQIs for measurement parameters based on the survey responses of participating agencies and groups. These DQIs should be refined by the QA and operations workgroups.

2.0 INFORMATION FOR DATA QUALITY OBJECTIVES

The following information is suggested to serve as an initial discussion point for establishing Data Quality Objectives for IADN concentration measurements.

Maximum uncertainty that may be tolerated in the decision making process The maximum tolerable uncertainty has not been ascertained. For USEPA projects, such as the Urban Air Toxic Monitoring Program (UATMP) and Toxic Air Monitoring System (TAMS), that have similar objectives, the following uncertainties were found to be acceptable for decision making. Results were expressed as the probability of making two kinds of incorrect decisions, false positives and false negatives. A false positive decision is one in which a decision is made that the magnitude of the problem is such that additional actions are warranted when, in fact, there is no problem. A false negative decision is one in which a decision is made that the magnitude of the problem is such that additional actions are not warranted when, in fact, there is a problem. The maximum tolerable uncertainties for the UATMP and TAMS were as follows:

Less than a 0.1 probability of making a false positive decision at typical ambient levels or below

Less than a 0.01 probability of making a false negative decision at ten times typical ambient levels or above

Less than a 0.1 probability of making a false negative decision at typical ambient levels

Less than a 0.9 probability of making a false negative decision at one-tenth typical ambient levels or below

Primary intended use of the IADN measurement data The primary intended use of the data is to determine with a specified degree of confidence, the seasonal and annual averages for deposition of certain toxic chemicals to the Great Lakes from the air. The relative importance of the atmospheric pathway for the loading of the Great Lakes basin of selected toxic chemicals is to be determined by determining the concentration of these chemicals in precipitation and air, and then estimating the deposition of each of these substances to each of the Great Lakes using the mass balance loading equation(s) given in Section 1.3 and Appendix C.

Secondary intended uses of the data The secondary uses of the data may include the following:

1. Determine the spatial and temporal distribution of air and precipitation concentrations and loadings to the Great Lakes.

2. Establish source-receptor relationships for the selected toxic chemicals to be used as a basis for developing a source control strategy.

3. Assess whether air loadings of toxic chemicals to the Great Lakes represent a potential for adverse human health effects.

4. Assess whether air loadings of toxic chemicals to the Great Lakes represent a potential for adverse effects on ecosystems and biota.

5. Determine if air loadings of toxic chemicals to the Great Lakes are increasing, decreasing, or remaining relatively constant over time (trend analysis studies).

Spatial and temporal bounds for the data The spatial bounds for the data include the Great Lakes basin. There are to be five research grade master stations and up to 22 routine measurement or satellite stations located throughout the Great Lakes basin (which is based on drainage area and is defined in the Great lakes Water Quality Agreement). There is to be at least one master station adjacent to each of the Great Lakes and up to four satellite stations per lake. The stations are to meet the IADN siting criteria which were developed to ensure regional representativeness. In addition, there are to be two additional sites, one located west and the other east of the Great Lakes basin. Other locations (particularly for source/receptor studies) may be based upon initial measurement results. Finally, the use of ships or other offshore platforms is also to be considered.

The temporal bounds of the study involve both duration and resolution. The IADN study is to begin in January 1990 and continue for at least six years. Temporal resolution is to be based on the minimum sampling duration necessary to achieve adequate data quality. Balancing considerations of the current state of the art of sampling and analytical procedures with practical considerations of resource constraints and current practices, the following sampling frequency and duration, based on current practice, are likely to be adequate:

Organics in precipitation - one cumulative sample every 14 or 28 days
Metals in precipitation - one cumulative sample every 14 or 28 days
Organics in air - one 24-hour sample every 6 or 12 days
Metals in air - one 24-hour sample every 6 or 12 days

However, these schedules should be reassessed by the operational and QA work groups, especially to determine whether semi-monthly or monthly sampling for compounds in precipitation is preferable for determining seasonal estimates. Alternate schedules are acceptable, but must demonstrate equivalence with the established "standard" schedule. Also, if initial measurements suggest that source/receptor studies should be given greater priority, then shorter duration and/or more frequent sampling may be necessary. In addition, meteorological parameters (such as temperature, relative humidity, wind speed and direction, and solar radiation) may be adequately measured as continuous measurements reported as hourly averages.

General sampling procedures The general sampling procedures and analysis methods are summarized in Table I-1. Some procedures used by different groups may appear similar, but may differ significantly in detail. The comparability of the various sampling and analysis methods used by different groups is to be assessed during the initial stages of IADN. Any recommendations for uniform or preferred methods must consider the results of that assessment.

General parameters to be measured Criteria for determining the chemical substances to be measured include the following:

> The substances are listed in List 1 of Annex 1 of the Great Lakes Water Quality Agreement which includes substances which are believed to be both toxic and present in the Great Lakes.
>
> The substance is an established or perceived water quality problem based on (1) toxicology of the substance, (2) potential for persistence or bioaccumulation, (3) significant ecosystem loading, and (4) potential human health concerns.
>
> The substance is on the Water Quality Board's list of critical pollutants.
>
> Evidence exists that the chemical is present in the atmosphere (rain, snow, aerosol) and/or has an important atmospheric pathway (volatilization, occurrence in remote lake/peat sediments).
>
> The chemical should be feasible to measure in a "routine" monitoring network, where routine means that a sequence of collection, transport, processing, and analysis procedures can be performed in a prescribed manner.

Dry deposition will be estimated using air concentrations. During the first phase, the following toxic chemicals shall be measured:

1. PCBs - Total PCBs and major congeners
2. HCHs - and isomers
3. PAHs - including B[a]P as a goal
4. Pb

Table I-2 lists all PCB congeners and indicates which congeners are not in commercially produced PCB mixtures, those congeners that are included in Mullin's Standard, and those congeners that are coplanar. Table I-2 also indicates the congeners analyzed for by the participating laboratories and those congeners which participating agencies recommended for analysis based on several criteria. Table I-3 gives a "short list" of 60 congeners that two or more participating agencies recommended for priority analysis. About one third of these priority congeners were recommended by three or more agencies. Priority was based on the presence of the congener in a suite of congeners that routinely constitute 90 to 95 percent of the total PCB mass, the possibility of large concentrations in the vapour phase, or the toxicity of the congener. This priority list should be refined further by the Operations, Data Interpretation, and QA workgroups. Total PCBs will be determined as the total of the individual congeners in the suite.

As a second priority, the following toxic compounds shall be measured:

5. Chlorinated pesticides - DDT (plus metabolites), chlordane, nonachlor, endrin, HCB, heptachlor epoxide, methoxychlor, and dieldrin

6. Trace metals - As, Se, Cd, Hg

The selection of specific compounds within families will be established by the PMG with regular consultation of the Data Interpretation workgroup. Additional compounds that may require methods development may be added later after regular consultation and review and approval by the PMG.

Acceptable limits for uncertainty in the parameters The acceptable limits are to be given in terms of precision, accuracy, detection limits, representativeness, and comparability. They are to comply with the maximum tolerable uncertainty for decision makers.

Representativeness is to be assessed qualitatively by adherence to IADN siting criteria (see Appendix D). The main siting criteria is that monitoring sites be representative of the regional atmospheric environment over the lakes and not unduly influenced by nearby sources. Thus, sites should be at least 40 km from major sources and larger urban population centres (population >10,000); at least 10 km from other important sources such as urban areas (population of 1000 to 10,000), mining and manufacturing facilities, major highways, commercial areas, and smaller sources; at least 1 km from local sources such as vehicle traffic, farms and tilled fields, landfills, and small towns; at least 250 m from residences, parking lots, grazing animals, and public roads, and other sources in the immediate area; and upwind (based on prevailing winds) of any residences within 1 km. In addition, samplers are to be located on open level terrain with regionally representative ground cover (preferably grass no taller than 20 cm), have a 2:1 to any obstruction height (10:1 for solid structures), sheltered by trees at a distance of 2.5-4 times tree height. Sites should also be no more than 1 km from the lake shore and located so that the prevailing winds are onshore from the lake. No development should be planned in the vicinity of the site (1 km).

Very few IADN measurements have standard or reference methods. Comparability is to be assessed through laboratory intercomparisons, use of intercomparison monitoring sites, and comparison with other monitoring and analysis methods. Comparability is also to be enhanced by the use of the same reporting units and standard conditions. Consideration should be given to the development of a central standards repository for use by all contributors to the IADN program.

In general, data quality objectives for precision and accuracy necessary to achieve the desired level of uncertainty acceptable to decision makers are on the order of ±30 percent for a typical ambient level. For measurements of the concentration of certain toxic chemicals, this degree of uncertainty is attainable for some of the substances, given the current state of the art as summarized in Tables I-4 through I-20. For determinations of the deposition of most toxic substances, the degree of uncertainty is likely to be on the order of a factor of two to five and not acceptable to decision makers.

Data completeness goals In general, completeness objectives for concentration measurements of 75% overall (yearly) and 66% overall (seasonal) per site should be readily attainable. Overall completeness is the product of sampling and analysis completeness. Completeness is defined as the percentage of valid samples collected and analyzed compared to the total expected under typical operating conditions. Valid samples include those for compounds for which the concentration may be determined to be below detection limits. Data completeness goals are discussed further in Section 3.0 of this appendix.

Methods for assessment of uncertainty Methods for the assessment of uncertainty should be uniform for the participating groups. Tables I-4 through I-18 summarize the general measures to be used to assess accuracy, precision, limits of detection, and completeness. Additional information and formulas are given in Sections 3.1 through 3.4 of this appendix. Detailed methods should be determined by the QA Working Group.

Current data quality objectives are not likely to be met given best estimates for measurement uncertainty for the current state of the art. Either the uncertainty acceptable to decision makers must be relaxed or significant efforts must be made to improve measurement uncertainties for concentration measurements and estimation of constants, terms, and parameters for deposition estimates.

3.0 DATA QUALITY INDICATORS

Data Quality Indicators are measurement QA objectives that are likely to be achieved. They are based on the existing state of the art without regard to whether or not meeting such objectives will achieve program goals. Table I-19 is an overall summary of DQIs for concentration and meteorological measurements while Table I-20 summarizes the methods used to determine the DQIs. The DQIs listed in Table I-19 were based on responses by participating agencies to a questionnaire sent out following a workshop held to consider a preliminary draft of this QAPP. There are numerous differences in the measures used by the agencies to determine their DQIs. For example, some groups use a confidence level of .99 while others use .95. In many cases, requested information was either not available or not provided. Thus, these DQIs should be reviewed and a consensus achieved on their reasonableness for all IADN groups.

The following terms and formulas are to be used to assess accuracy, precision, detection limits, and completeness.

3.1 CALCULATION OF ACCURACY

Accuracy is the degree of agreement between a measurement (or the average of measurements of the same quantity) and an acceptance reference or true value. For most of the measurements taken for IADN, there are no known true values or even reference methods for determining the quantity of interest. Thus, overall accuracy is often unknown and unknowable. However, certain portions of a measurement process may have their accuracy assessed. For example, laboratory accuracy may be characterized through the use of laboratory surrogate spikes and laboratory matrix spikes. Usually, laboratory accuracy is reported as percent recovery. For some measurements, such as TSP and PM-10 where there is no standard atmospheric aerosol, determinations of accuracy may be limited to the accuracy of the flow rate measurement or volume of air sampled. For Tables I-4, I-9, and I-14, agencies should provide values based on a mean of laboratory spike recovery data (Equations 3-2 and 3-5), with n   10. If they also have data from SRM's, an additional column should be included using Equation 3-1.

3.1.1 Percent Difference from Standard Reference Material (SRM)

The percent difference for a measured value from the certified reference value is given by

$$\%Diff_{SRM} \quad 100 \times \left(\frac{X_m \quad X_{SRM}}{X_{SRM}} \right) \tag{3-1}$$

where $\%Diff_{SRM}$ = percent difference
X_m = measured value
X_{SRM} = certified SRM value

3.1.2 Percent Recovery for Matrix Spikes

$$\%\ R \quad 100 \times \left[\frac{C_s \quad C_u}{C_{sa}} \right] \tag{3-2}$$

where $\%R$ = percent recovery
C_s = measured concentration in spiked aliquot
C_u = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

3.2 CALCULATION OF PRECISION

The term precision is used as a measure of the mutual agreement among individual measurements of the same property under prescribed similar conditions. Overall precision usually refers to the degree of agreement for the entire sampling, operational, and analysis system. It is derived from multiple measurements from collocated sampling instruments. Analytical precision refers to the precision of the analysis portion of the measurement process. It is usually determined from analyses of laboratory surrogate spikes and laboratory matrix spikes.

For Tables I-5, I-10, and I-15, agencies should provide values based the relative standard deviation (RSD) of laboratory matrix spikes (Equations 3-2, 3-4, 3-5, and 3-3). For overall precision in Tables I-6, I-11, and I-16, agencies with <u>two</u> collocated samplers should provide data based on Equations 3-6 <u>and</u> 3-7. Equation 3-6 is a parametric measure of precision and Equation 3-7 is a non-parametric statistic. The QA Workgroup will evaluate the merits of both the parametric and non-parametric approaches and make a final recommendation. For agencies with three collocated samplers, values for Tables I-6, I-11, and I-16 should be based on the standard deviation of the triplicate samples (Equation 3-4). A three-way calculation of the median absolute difference (MAD(D), Equation 3-7) should also be determined.

3.2.1 Replicate Measurements: Relative Standard Deviation (RSD) or Coefficient of Variation (CV)

$$CV = RSD = \left(\frac{S}{\overline{C}}\right) \times 100 \qquad (3\text{-}3)$$

where CV = coefficient of variation
RSD = relative standard deviation
S = standard deviation
$\overline{C}$ = mean value of replicate observed values

and the Standard Deviation, S, for an individual sample set is defined as:

$$S = \left[\frac{1}{n-1}\sum_{i=1}^{n}(C_i - \overline{C})^2\right]^{1/2} \qquad (3\text{-}4)$$

where C_i = observed value of the i[th] replicate
$\overline{C}$ = mean of replicate observed values
n = number of replicates

and the mean, $\overline{C}$, is defined as:

$$\overline{C} = \frac{1}{n}\sum_{i=1}^{n} C_i \qquad (3\text{-}5)$$

3.2.2 Duplicate Measurements: Relative Percent Difference (RPD)

For an individual sample set:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100 \qquad (3\text{-}6)$$

where RPD = relative percent difference
C_1 = first of two observed values
C_2 = second of two observed values

3.2.3 Median Absolute Difference - MAD(D)

$$Median\ of\ \left| x_{1i} - x_{2i} \right| \tag{3-7}$$

where x_{1i} = first of two observed values
x_{2i} = second of two observed values

3.2.4 Geometric Distributions

When the data set has a log-normal distribution, Equations 3-4 and 3-5 are not appropriate, and the geometric mean, $\overline{X}_g$, and geometric standard deviation, S_g are used instead. These statistics are referenced in Appendix L.

$$\overline{X}_g = \left[\prod_{i=1}^{n} x_i \right]^{\frac{1}{n}} \tag{3-8a}$$

OR

$$\overline{X}_g = antilog \left[\frac{\sum_{i=1}^{n} \log x_i}{n} \right] \tag{3-8b}$$

$$S_g = antilog \left[\frac{\sum_{i=1}^{n} (\log X_i - \overline{\log x})^2}{n-1} \right]^{1/2} \tag{3-9}$$

3.3 LIMIT OF DETECTION

The limit of detection for an analytical method is the minimum level or concentration of the analyte which can be observed by the instrument and distinguished from instrument noise with a specified degree of probability. Several different terms may be used to describe how the detection limits are derived. The following terms and formulas are commonly used by the groups and agencies participating in IADN.

3.3.1 Instrument Detection Limit (IDL)

The instrument detection limit (IDL) is the lowest concentration of analyte that an analytical instrument can detect and which is statistically different from the response obtained from the background instrumental noise. The IDL is established by adding the analyte in reagent blank water or solvent to give a concentration within a few times the estimated IDL and calculating the standard deviation, *S*, for seven or more replicate measurements. The 95% or 99% confidence level is then used to calculate the IDL according to:

$$IDL = t_{(n-1,\ 1-\ )} \times S \qquad (3\text{-}10)$$

where $t_{(n-1,\ 1-\ )}$ is the value for a one-sided Students' t-distribution for n-1 degrees of freedom and 1- is either 0.95 (NWRI) or 0.99 (EPA). The IDL indicates the absolute sensitivity of the analytical technique or instrument.

3.3.2 Method Detection Limit (MDL)

The method detection limit (MDL) is the lowest concentration of analyte in distilled water or appropriate solvent that a method can detect reliably and is statistically different from a blank carried through the complete method, including extraction and pretreatment of the sample. The MDL is specified based on replicate analyses of seven or more measurements with a specified confidence level.

$$MDL = t_{(n-1,\ 1-\ )} \times S \qquad (3\text{-}11)$$

where $t_{(n-1,\ 1-\ )}$ is the value for a one-sided Students' t-distribution for n-1 degrees of freedom and 1- is either 0.95 (NWRI) or 0.99 (EPA, MOEE). The IDL indicates the absolute sensitivity of the analytical technique or instrument. If the MDL is experimentally evaluated for each matrix using the analysis of samples or spiked samples, then it is called a matrix-specific Method Detection Limit.

3.3.3 Limit of Detection (LOD)

The limit of detection (LOD) is defined for the case where repeated analyses of field blanks show a positive response for the analyte. The LOD is then given by

$$\mathrm{LOD} = \bar{C}_b + t_{(n-1,\ 1-\ )} \times S \tag{3-12}$$

where $\bar{C}_b$ is the average level for the field blanks, S is the standard deviation of the replicate determinations (seven or more), and $t_{(n-1,\ 1-\ )}$ is the Students' t-distribution for n-1 degrees of freedom and 1- is chosen to be 0.95 or 0.99. For the IADN, $t_{(n-1,\ 1-\ )}$ is assumed to be 3. Thus

$$\mathrm{LOD\ (IADN)} = \bar{C}_b + 3 \times S \tag{3-13}$$

The LOD will be the larger of Equation 3-11 or 3-13.

3.3.4 IADN Limit of Detection

The IADN limit of detection was defined in the previous section (the larger of Equation 3-11 or 3-13). However, laboratories differ in how they routinely handle and report values that are at or below certain detection limits. Thus a data reduction protocol has been developed to standardize the reporting of certain data. This protocol is given in Appendix L. For Tables I-7, I-12, and I-17, agencies must specify which equation was used.

3.3.5 Special Detection Limit Terms

The MOEE uses two special terms, "W" and "T", to report low level data. They are derived in a manner similar to that used to obtain the MDL. "W" values are obtained by choosing a value (such as 1, 2, 5, 10, 20, etc.) just below the calculated standard deviation and calling it the "W" value. The "W" value is roughly equivalent to a confidence level of 25 percent (or about 2/3 of the standard deviation). MDLs are about 3 times to 5 times the "W" values depending on the specific analysis. The "T" values are chosen by each individual laboratory section and are normally 5 times or 10 times the "W" value. The "T" value is chosen so that it is at least as large as the MDL, but is usually larger. Data are then reported when values are below the "T" values but not when they are below the "W" values.

3.4 COMPLETENESS

Completeness is defined as the percentage of valid data collected and analyzed compared to the total expected to be obtained under normal operating conditions. Overall completeness accounts for both sampling and analysis completeness, each of which may be specified separately. Valid samples include those for compounds in which the concentration is determined to be below detection limits. There may also be different completeness goals for various parameters and time periods. For IADN, completeness is to be expressed as overall completeness for a given parameter at a given site for periods of a year and a season (three months). IADN completeness goals tend to be the lowest acceptable common denominator; individual agencies and groups may have more stringent requirements.

There are also several different completeness measures in common use for summarizing precipitation statistics. The following definitions are based on those of the Canada-U.S. Unified Deposition Data Base Committee (UDDBC). Percent Valid Samples corresponds to the one used for IADN in Tables I-8, I-13, and I-18. Reporting the other precipitation statistics is voluntary unless the QA and operations workgroups later determine otherwise.

Percent Valid Samples (%VSMP) Percent of wet deposition samples that have valid concentration measurements.

Percent Precipitation Coverage Length (%PCL) The percent of the summary period (e.g., year or season) for which information is available on whether or not precipitation occurred. (This measure does not consider whether or not there was a valid precipitation chemistry sample.)

Percent Total Precipitation (%TP) The percent of the total precipitation data measured during the summary period that is associated with valid samples.

Percent Valid Sample Length (%VSL) Percent of days during the summary period that are associated with valid sample periods. (Sample periods with no precipitation are considered valid samples.)

TABLE I-1. SUMMARY OF SAMPLING AND ANALYSIS METHODS[a]

Parameter	Agency	Sampling Method[b]	Sampling Frequency[c]	Analytical Method[d]	Reporting Units
Air Organics					
(PCBs, Pesticides, PAHs)	AES	PUF Sampler/GFF+PUF	24 h/6 d	Soxhlet/GC/ECD	pg/m^3
	MOEE	HiVol/GFF+XAD2®	96 h/14 d	Soxhlet/GC/ECD or GC/MS	
	ISWS	HiVol/GFF+PUF,XAD2®	24 h/12 d	Soxhlet/GC/ECD	pg/m^3
Air Metals					
(Pb et al.)	AES	PM10 HiVol/W41F	24 h/6 d	ICP, INAA	ng/m^3
	MOEE	LoVol/W40F	28 d	ICP, AAS	g/m^3
	ISWS/EPA	PM10 Dichot/TF	96 h/mo.	XRF	ng/m^3
Precipitation Organics					
(PCBs, Pesticides, PAHs)	NWRI	MIC-B/XAD2®	14 days	DCM/GC/ECD	
	IWD[e]	MIC-B/DCM	14 days	---/GC/ECD	
	MOEE	MIC-B/XAD2®	28 days	DCM/GC/ECD	
	ISWS	MIC-B/XAD2®	28 days	SOXHLET/GC/ECD	ng/L
Precipitation Metals					
(Pb et al.)	NWRI	MIC-AU	14 days	ICP, AAS	
	MOEE	MIC-A	28 days	ICP-MS	
	EPA-GLAD	Aerochem Metrics	7 days	AAS, ICP	µg/L
Related Air Measurements					
Total Organic Carbon	AES	HiVol/GFF	24 h/6 d	Thermal Desorption	g/m^3
	ISWS	HiVol/GFF	24 h/6 d	CO_2 Analysis	g/m^3
Total Suspended Part.	AES, ISWS	HiVol/GFF	24 h/6 d	Gravimetric	g/m^3
PM10	ISWS	Dichot/TF	96 h/mo.	Gravimetric	g/m^3
Meteorology					
Temperature	AES, ISWS	Thermistor	hrly. avg.	Direct Reading	C
Relative Humidity	AES, ISWS	Hygristor	hrly. avg.	Direct Reading	Percent
Wind Speed	AES, ISWS	Anemometer	hrly. avg.	Direct Reading	m/s
Wind Direction	AES, ISWS	Vane	hrly. avg.	Direct Reading	Degrees
Precipitation Amount	AES, MOEE	Type B Rain Gauge (RG)	24 hours	Direct Reading	mm
	ISWS	Belfort Recording RG	continuous	Direct Reading	mm
Solar Irradiation	AES	Pyranometer	hrly. avg.	Direct Reading	w/m^2
	ISWS	Pyranometer	hrly. avg.	Direct Reading	Langleys

NOTES:

[a] Sampling and analysis methods used by different groups may appear similar, but differ significantly in operational and other details.
[b] Sampling methods used by different groups may appear similar, but differ significantly in important details. Some sampling methods are given in the form sampler/collection media.
[c] Sampling frequency is sometimes given as sample duration/sampling interval.
[d] Analytical methods used by different groups may appear similar, but differ significantly in important details. Some analytical methods are given in the form extraction method/analysis method/detection method.
[e] NLET analyzes for total PCBs while other groups analyze for congener specific PCBs and determine total PCBs as the sum of the congeners.

KEY TO ABBREVIATIONS:

AAS	atomic absorption spectroscopy
DCM	dichloromethane solvent
Dichot	dichotomous sampler
ECD	electron capture detector
GC	gas chromatography
GFF	glass fibre filter
HiVol	high volume sampler
ICP	inductively coupled plasma spectrometry
INAA	instrumental neutron activation analysis
LoVol	low volume sampler
MIC-A	MIC type A precipitation sampler
MIC-AU	MIC type AU precipitation sampler
MIC-B	MIC type B precipitation sampler
MS	mass spectrometry
PM10	particulate matter less than 10 m in diameter
PM10 Dichot	dichotomous sampler with a PM10 inlet
PM10 HiVol	high volume sampler with a PM10 size selective inlet
PUF	polyurethane foam plug
TF	Teflon® filter
W40F	Whatman 40 filter
W41F	Whatman 41 filter
XAD2®	XAD-2® resin
XRF	x-ray fluorescence

TABLE I-2. PCB CONGENERS

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
1	mono	2-	2051-60-7	Y	Y	Y		
2	mono	3-	2051-61-8					
3	mono	4-	2051-62-9	Y	Y	Y		
4	di	2,2'-	13029-08-8	Y	Y+	Y+	Y	Y+
5	di	2,3-	16605-91-7	Y	Y,S+	Y+	Y,R	Y,S+
6	di	2,3'-	25569-80-6	Y	Y,S		Y,R	Y,H,S
7	di	2,4-	33284-50-3	Y	Y	Y		Y
8	di	2,4'-	34883-43-7	Y	Y+	Y+	Y,R	Y,S+
9	di	2,5-	34883-39-1					
10	di	2,6-	33146-45-1	Y	Y+	Y+	Y	Y+
11*	**di**	**3,3'-**	**2050-67-1**					
12*	**di**	**3,4-**	**2974-92-7**	**Y**	**Y+**	**Y+**		**Y+**
13*	**di**	**3,4'-**	**2974-90-5**	**Y**	**Y+**	**Y+**		**Y+**
14*	**di**	**3,5-**	**34883-41-5**					**Surr**
15	di	4,4'-	2050-68-2			(Y),R	Y,R	
16	tri	2,2',3-	38444-78-9	Y	Y,S+	Y	Y,R	Y,S+
17	tri	2,2',4-	37680-66-3	Y	Y,S	Y	Y,R	Y,HV,S
18	tri	2,2',5-	37680-65-2	Y	Y,S	Y	Y,R	Y,HV,S
19	tri	2,2',6-	38444-73-4	Y	Y	Y		Y
20	tri	2,3,3'-	38444-84-7					
21*	**tri**	**2,3,4-**	**55702-46-0**	**Y**	**Y,S+**		**Y,R**	**Y,S**
22	tri	2,3,4'-	38444-85-8	Y	Y,S	Y+	Y,R	Y,H,S
23*	**tri**	**2,3,5-**	**55720-44-0**					
24	tri	2,3,6-	55702-45-9	Y	Y+	Y+		Y+
25	tri	2,3',4-	55712-37-3	Y	Y	Y		Y
26	tri	2,3',5-	38444-81-4	Y	Y	Y		Y
27	tri	2,3',6-	38444-76-7	Y	Y+	Y+		Y+
28	tri	2,4,4'-	7012-37-5	Y	Y,S		Y,R	Y,H,S+
29	tri	2,4,5-	15862-07-4	Y	Y	Y	Y	Y
30*	**tri**	**2,4,6-**	**35693-92-6**	**Y**	**Y**			**Int Std**
31	tri	2,4',5-	16606-02-3	Y	Y,S	Y,R	Y,R	Y,H,S+
32	tri	2,4',6-	38444-77-8	Y	Y,S+	Y	Y,R	Y,S+

(continued)

TABLE I-2. PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
33	tri	2',3,4-	38444-86-9	Y	Y,S+	Y	Y,R	Y,H,S
34	tri	2',3,5-	37680-68-5					
35	tri	3,3',4-	37680-69-6					
36*	**tri**	**3,3',5-**	**38444-87-0**					
37	tri	3,4,4'-	38444-90-5	Y	Y,S+	Y+	Y,R	Y,T,H,S+
38*	**tri**	**3,4,5-**	**53555-66-1**					
39*	**tri**	**3,4',5-**	**38444-88-1**					
40	tetra	2,2',3,3'-	38444-93-8	Y	Y	Y,R	Y	Y
41	tetra	2,2',3,4-	52663-59-9	Y	Y,S+	Y+	Y,R	Y,H,S+
42	tetra	2,2',3,4'-	36559-22-5	Y	Y,S+	Y+	Y,R	Y,H,S+
43*	**tetra**	**2,2',3,5-**	**70362-46-8**	**Y**	**Y,S+**		**Y**	**Y,S**
44	tetra	2,2',3,5'-	41464-39-5	Y	Y,S	Y,R	Y,R	Y,H,S
45	tetra	2,2',3,6-	70362-45-7	Y	Y	Y		Y
46	tetra	2,2',3,6'-	41464-47-5	Y	Y	Y		Y
47	tetra	2,2',4,4'-	2437-79-8	Y	Y,S+	Y	Y,R	Y,H,S+
48	tetra	2,2',4,5-	70362-47-9	Y	Y,S+	Y	Y,R	Y,H,S+
49	tetra	2,2',4,5'-	41464-40-8	Y	Y,S	Y,R	Y,R	Y,H,S
50*	**tetra**	**2,2',4,6-**	**62796-65-0**				**Y,R**	
51	tetra	2,2',4,6'-	68194-04-7	Y	Y	Y+		Y
52	tetra	2,2',5,5'-	35693-99-3	Y	Y,S+	Y,R	Y,R	Y,H,S
53	tetra	2,2',5,6'-	41464-41-9	Y	Y,S+	Y	Y,R	Y,S
54*	**tetra**	**2,2',6,6'-**	**15968-05-5**					
55*	**tetra**	**2,3,3',4-**	**74338-24-2**					
56	tetra	2,3,3',4'-	41464-43-1	Y	Y,S+	Y+	Y,R	Y,H,S+
57*	**tetra**	**2,3,3',5-**	**41464-49-7**					
58*	**tetra**	**2,3,3',5'-**	**70424-67-8**					
59	tetra	2,3,3',6-	74472-33-6					
60	tetra	2,3,4,4'-	33025-41-1	Y	Y,S+	Y,R+	Y,R	Y,H,S+
61*	**tetra**	**2,3,4,5-**	**33284-53-6**				**Y,R**	
62*	**tetra**	**2,3,4,6-**	**54230-22-7**					
63	tetra	2,3,4',5-	74472-34-7	Y	Y	Y		Y
64	tetra	2,3,4',6-	52663-58-8	Y	Y,S+	Y+	Y,R	Y,H,S+

(continued)

TABLE I-2. PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
65*	**tetra**	**2,3,5,6-**	**33284-54-7**					**Surr**
66	tetra	2,3',4,4'-	32598-10-0		Y,S+	Y	Y,R	Y,S
67	tetra	2,3',4,5-	73575-53-8	Y				Y
68*	**tetra**	**2,3',4,5'-**	**73575-52-7**					
69	tetra	2,3',4,6-	60233-24-1					
70	tetra	2,3',4',5-	32598-11-1	Y	Y,S+	Y+	Y,R	Y,H,S+
71*	**tetra**	**2,3',4',6-**	**41464-46-4**	**Y**	**Y,S+**		**Y,R**	**Y,H,S+**
72*	**tetra**	**2,3',5,5'-**	**41464-42-0**					
73*	**tetra**	**2,3',5',6-**	**74338-23-1**					
74	tetra	2,4,4',5-	32690-93-0	Y	Y,S	Y	Y,R	Y,S
75	tetra	2,4,4',6-	32598-12-2				Y	T
76*	**tetra**	**2',3,4,5-**	**70362-48-0**	**Y**	**Y,S+**	**Y+**	**Y,R**	**Y,H,S+**
77	tetra	3,3',4,4'-	32598-13-3	Y	Y,S+	Y,R+	Y,R	Y,T
78*	**tetra**	**3,3',4,5-**	**70362-49-1**					
79*	**tetra**	**3,3',4,5'-**	**41464-48-6**					**T**
80*	**tetra**	**3,3',5,5'-**	**33284-52-5**					
81*	**tetra**	**3,4,4',5-**	**70362-50-4**	**Y**	**Y,S+**	**Y+**	**Y,R**	**Y,S**
82	penta	2,2',3,3',4-	52663-62-4	Y	Y	Y	Y	Y,T
83	penta	2,2',3,3',5-	60145-20-2	Y	Y	Y		Y,T
84	penta	2,2',3,3',6-	52663-60-2	Y	Y,S+	Y+	Y,R	Y,H,S+
85	penta	2,2',3,4,4'-	65510-45-4	Y	Y+	Y	Y	Y
86*	**penta**	**2,2',3,4,5-**	**55312-69-1**					
87	penta	2,2',3,4,5'-	38380-02-8	Y	Y,S+	R	Y,R	Y,S
88	penta	2,2',3,4,6-	55215-17-3					
89*	**penta**	**2,2',3,4,6'-**	**73575-57-2**	**Y**	**Y**	**Y**		**Y**
90	penta	2,2',3,4',5-	68194-07-0					
91	penta	2,2',3,4',6-	68194-05-8	Y	Y	Y+		Y,T
92	penta	2,2',3,5,5'-	52663-61-3	Y	Y,S+	Y+	Y,R	Y,H,S+
93*	**penta**	**2,2',3,5,6-**	**73575-56-1**					**T**
94*	**penta**	**2,2',3,5,6'-**	**73575-55-0**					**T**
95	penta	2,2',3,5',6-	38379-99-6	Y	Y,S+	Y	Y,R	Y,H,S
96	penta	2,2',3,6,6'-	73575-54-9					

(continued)

TABLE I-2. PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
97	penta	2,2',3',4,5-	41464-51-1	Y	Y,S	Y	Y,R	Y
98*	**penta**	**2,2',3',4,6-**	**60233-25-2**					
99	penta	2,2',4,4',5-	38380-01-7	Y	Y,S	Y	Y,R	Y,T,S
100	penta	2,2',4,4',6-	39485-83-1	Y	Y	Y		Y,T
101	penta	2,2',4,5,5'-	37680-73-2	Y	Y,S	Y,R	Y,R	Y,H,S,T
102*	**penta**	**2,2',4,5,6'-**	**68194-06-9**					**T**
103*	**penta**	**2,2',4,5',6-**	**60145-21-3**				**Y**	**T**
104*	**penta**	**2,2',4,6,6'-**	**56558-16-8**					**T**
105	penta	2,3,3',4,4'-	32598-14-4	Y	Y,S	Y,R+	Y,R	Y,T,H,S+
106*	**penta**	**2,3,3',4,5-**	**70424-69-0**					**T**
107	penta	2,3,3',4',5-	70424-68-9	Y	Y	Y+		Y
108*	**penta**	**2,3,3',4,5'-**	**70362-41-3**					
109*	**penta**	**2,3,3',4,6-**	**74472-35-8**					
110	penta	2,3,3',4',6-	38380-03-9	Y	Y,S+	Y	Y,R	Y,H,S
111*	**penta**	**2,3,3',5,5'-**	**39635-32-0**					
112*	**penta**	**2,3,3',5,6-**	**74472-36-9**					
113*	**penta**	**2,3,3',5',6-**	**68194-10-5**					
114	penta	2,3,4,4',5-	74472-37-0	Y	Y+	Y+	Y,R	Y,T+
115	penta	2,3,4,4',6-	74472-38-1					
116*	**penta**	**2,3,4,5,6-**	**18259-05-7**					
117*	**penta**	**2,3,4',5,6-**	**68194-11-6**					
118	penta	2,3',4,4',5-	31508-00-6	Y	Y,S	Y,R+	Y,R	Y,S
119	penta	2,3',4,4',6-	56558-17-9	Y	Y,S	Y	Y,R	Y,S
120*	**penta**	**2,3',4,5,5'-**	**68194-12-7**					
121*	**penta**	**2,3',4,5',6-**	**56558-18-0**			**Y+**		
122	penta	2',3,3',4,5-	76842-07-4					
123	penta	2',3,4,4',5-	65510-44-3			Y+		
124*	**penta**	**2',3,4,5,5'-**	**70424-70-3**	**Y**				**Y+**
125*	**penta**	**2',3,4,5,6'-**	**74472-39-2**					
126	penta	3,3',4,4',5-	57465-28-8			Y+	Y,R	T
127*	**penta**	**3,3',4,5,5'-**	**39635-33-1**					
128	hexa	2,2',3,3',4,4'-	38380-07-3	Y	Y	Y	Y	Y

(continued)

TABLE I-2. PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
129	hexa	2,2',3,3',4,5-	55215-18-4	Y	Y+	Y	Y	Y
130	hexa	2,2',3,3',4,5'-	52663-66-8	Y	Y+			Y
131	hexa	2,2',3,3',4,6-	61798-70-7	Y	Y		Y	Y
132	hexa	2,2',3,3',4,6'-	38380-05-1	Y	Y,S+	Y+	Y,R	Y,H,S+
133*	**hexa**	**2,2',3,3',5,5'-**	**35694-04-3**					
134	hexa	2,2',3,3',5,6-	52704-70-8	Y	Y	Y+	Y	Y+
135	hexa	2,2',3,3',5,6'-	52744-13-5	Y	Y	Y+		Y+
136	hexa	2,2',3,3',6,6'-	38411-22-2	Y	Y	Y+	Y,R	Y
137	hexa	2,2',3,4,4',5-	35694-06-5	Y	Y+	Y+	Y	Y+
138	hexa	2,2',3,4,4',5'-	35065-28-2	Y	Y,S+	Y+	Y,R	Y,H,S+
139*	**hexa**	**2,2',3,4,4',6-**	**56030-56-9**					
140*	**hexa**	**2,2',3,4,4',6'-**	**59291-64-4**					
141	hexa	2,2',3,4,5,5'-	52712-04-6	Y	Y	Y	Y	Y
142*	**hexa**	**2,2',3,4,5,6-**	**41411-61-4**					
143*	**hexa**	**2,2',3,4,5,6'-**	**68194-15-0**			**Y,R+**		
144*	**hexa**	**2,2',3,4,5',6-**	**68194-14-9**	**Y**	**Y**	**Y+**	**Y**	**Y+**
145*	**hexa**	**2,2',3,4,6,6'-**	**74472-40-5**					
146	hexa	2,2',3,4',5,5'-	51908-16-8	Y	Y	Y		Y
147*	**hexa**	**2,2',3,4',5,6-**	**68194-13-8**	**Y**				**Y+**
148*	**hexa**	**2,2',3,4',5,6'-**	**74472-41-6**					
149	hexa	2,2',3,4',5',6-	38380-04-0	Y	Y,S	Y+	Y,R	Y,S
150	hexa	2,2',3,4',6,6'-	68194-08-1					
151	hexa	2,2',3,5,5',6-	52663-63-5	Y	Y	Y	Y	Y
152*	**hexa**	**2,2',3,5,6,6'-**	**68194-09-2**					
153	hexa	2,2',4,4',5,5'-	35065-27-1	Y	Y,S+	Y,R	Y,R	Y,S+
154*	**hexa**	**2,2',4,4',6,6'-**	**60145-22-4**			**Y,R**		
155*	**hexa**	**2,2',4,4',6,6'-**	**33979-03-2**				**Y**	
156	hexa	2,3,3',4,4',5-	38380-08-4	Y	Y+	Y,R+	Y,R	Y,T
157	hexa	2,3,3',4,4',5'-	69782-90-7	Y	Y+	Y+	Y	Y+
158	hexa	2,3,3',4,4',6-	74472-42-7	Y	Y	Y	Y	Y
159*	**hexa**	**2,3,3',4,5,5'-**	**39635-35-3**			**Y**		
160	hexa	2,3,3',4,5,6-	41411-62-5					

(continued)

TABLE I-2. PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
161*	**hexa**	**2,3,3',4,5',6-**	**74472-43-8**					
162*	**hexa**	**2,3,3',4',5,5'-**	**39635-34-2**					
163*	**hexa**	**2,3,3',4',5,6-**	**74472-44-9**	**Y**	**Y,S+**	**Y+**	**Y,R**	**Y,H,S+**
164*	**hexa**	**2,3,3',4',5',6-**	**74472-45-0**					
165*	**hexa**	**2,3,3',5,5',6-**	**74472-46-1**					
166*	**hexa**	**2,3,4,4',5,6-**	**41411-63-6**					**Surr**
167	hexa	2,3',4,4',5,5'-	52663-72-6	Y	Y	Y	Y	Y
168*	**hexa**	**2,3',4,4',5',6-**	**59291-65-5**					
169	hexa	3,3',4,4',5,5'-	32774-16-6	Y			Y,R	Y
170	hepta	2,2',3,3',4,4',5-	35065-30-6	Y	Y+	Y	Y	Y+
171	hepta	2,2',3,3',4,5,6-	52663-71-5	Y	Y+	Y+	Y	Y+
172	hepta	2,2',3,3',4,5,5'-	52663-74-8	Y	Y+	Y		Y+
173	hepta	2,2',3,3',4,5,6-	68194-16-1	Y			Y,R	Y
174	hepta	2,2',3,3',4,5,6'-	38411-25-5	Y	Y	Y		Y
175	hepta	2,2',3,3',4,5',6-	40186-70-7	Y	Y	Y		Y
176	hepta	2,2',3,3',4,6,6'-	52663-65-7	Y	Y+	Y+		Y+
177	hepta	2,2',3,3',4',5,6-	52663-70-4	Y	Y	Y	Y	Y
178	hepta	2,2',3,3',5,5',6-	52663-67-9	Y	Y+	Y+		Y
179	hepta	2,2',3,3',5,6,6'-	52663-64-6					
180	hepta	2,2',3,4,4',5,5'-	35065-29-3	Y	Y	Y,R	Y,R	Y
181*	**hepta**	**2,2',3,4,4',5,6-**	**74472-47-2**					
182*	**hepta**	**2,2',3,4,4',5,6-**	**60145-23-5**	**Y**	**Y+**	**Y+**	**Y**	**Y+**
183	hepta	2,2',3,4,4',5',6'-	52663-69-1	Y	Y	Y	Y	Y
184*	**hepta**	**2,2',3,4,4',6,6'-**	**74472-48-3**					
185	hepta	2,2',3,4,5,5',6-	52712-05-7	Y	Y	Y	Y	Y
186*	**hepta**	**2,2',3,4,5,6,6'-**	**74472-49-4**					
187	hepta	2,2',3,4',5,5',6-	52663-68-0	Y	Y+	Y+	Y	Y+
188*	**hepta**	**2,2',3,4',5,6,6'-**	**74487-85-7**					
189	hepta	2,3,3',4,4',5,5'-	39635-31-9	Y	Y	Y		Y
190	hepta	2,3,3',4,4',5,6-	41411-64-7	Y	Y+	Y	Y	Y+
191	hepta	2,3,3',4,4',5',6-	74472-50-7	Y	Y	Y	Y,R	Y+
192*	**hepta**	**2,3,3',4,5,5',6-**	**74472-51-8**					

(continued)

TABLE I-2. PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
193	hepta	2,3,3',4',5,5',6-	69782-91-8	Y	Y	Y	Y	Y+
194	octa	2,2',3,3',4,4',5,5'-	35694-08-7	Y	Y	Y	Y,R	Y
195	octa	2,2',3,3',4,4',5,6-	52663-78-2	Y	Y+	Y+	Y	Y+
196	octa	2,2',3,3',4,4',5,6'-	42740-50-1	Y	Y+	Y+	Y	Y
197	octa	2,2',3,3',4,4',6,6'-	33091-17-7	Y	Y+	Y	Y	Y+
198	octa	2,2',3,3',4,5,5',6-	68194-17-2	Y	Y	Y	Y	Y
199	octa	2,2',3,3',4,5,5',6'-	52663-75-9	Y	Y	Y	Y	Y+
200	octa	2,2',3,3',4,5,6,6'-	52663-73-7	Y	Y+	Y+		Y+
201	octa	2,2',3,3',4,5',6,6'-	40186-71-8	Y	Y	Y	Y	Y
202	octa	2,2',3,3',5,5',6,6'-	2136-99-4	Y	Y+	Y+		Y+
203	octa	2,2',3,4,4',5,5',6-	52663-76-0	Y	Y+	Y+	Y	Y
204*	**octa**	**2,2',3,4,4',5,6,6'-**	**74472-52-9**	**Y**	**Y+**			**Int Std**
205	octa	2,3,3',4,4',5,5',6-	4472-53-0	Y	Y	Y	Y,R	Y
206	nona	2,2',3,3',4,4',5,5',6-	40186-72-9	Y	Y	Y	Y	Y
207	nona	2,2',3,3',4,4',5,6,6'-	52663-79-3	Y	Y	Y	Y	Y
208	nona	2,2',3,3',4,5,5',6,6'-	52663-77-1	Y	Y+	Y+		Y+
209	deca	2,2',3,3',4,4',5,5',6,6'	2051-24-3	Y	Y		Y	Y

NOTES: NLET determines total PCBs and not individual PCB congeners.
An * and **bold** are used to denote the 77 PCB congeners that do not exist in commercial mixtures. An indicates a coplanar PCB.
An (A) indicates that the laboratory only analyzes air samples.
A (P) indicates that the laboratory only analyzes precipitation samples.
An "H" indicates a priority based on high concentration and "HV" a priority based on high concentration in the vapour phase.
An "R" indicates a recommended priority based on either high concentration or toxicity.
An "S" indicates a congener to be included in a PCB "suite" which regularly comprises between 90 and 95% of total mass of PCBs in ambient air or has been added because of its toxicity.
A "T" indicates a recommended priority based on toxicity.
A "Y" indicates a congener that is analyzed for or is present.
A "+" indicates a congener that coelutes with another congener.
Int Std: Internal Standard
Surr: Surrogate Standard

TABLE I-3. SHORT LIST OF PRIORITY PCB CONGENERS

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
4	di	2,2'	13029-08-8	Y	Y+	Y+	Y	Y
5	di	2,3-	16605-91-7	Y	Y,S+	Y+	Y,R	Y,S+
6	di	2,3'-	25569-80-6	Y	Y,S	Y	Y,R	Y,H,S
8	di	2,4'-	34883-43-7	Y	Y+	Y+	Y,R	Y,S+
10	di	2,6-	25569-80-6	Y	Y+	Y+	Y	Y
15	di	4,4'-	2050-68-2			(Y),R	Y,R	
16	tri	2,2',3-	38444-78-9	Y	Y,S+	Y	Y,R	Y,S+
17	tri	2,2',4-	37680-66-3	Y	Y,S	Y	Y,R	Y,HV,S
18	tri	2,2',5-	37680-65-2	Y	Y,S	Y	Y,R	Y,HV,S
21*	**tri**	**2,3,4-**	**55702-46-0**	**Y**	**Y,S+**		**Y,R**	**Y,S**
22	tri	2,3,4'-	38444-85-8	Y	Y,S	Y+	Y,R	Y,H,S
28	tri	2,4,4'-	7012-37-5	Y	Y,S	Y	Y,R	Y,H,S+
31	tri	2,4',5-	16606-02-3	Y	Y,S	Y,R	Y,R	Y,H,S+
32	tri	2,4',6-	38444-77-8	Y	Y,S+	Y	Y,R	Y,S+
33	tri	2',3,4-	38444-86-9	Y	Y,S+	Y	Y,R	Y,H,S
37	tri	3,4,4'-	38444-90-5	Y	Y,S+	Y+	Y,R	Y,T,H,S+
40	tetra	2,2',3,3'-	38444-93-8	Y	Y	Y,R	Y	Y
41	tetra	2,2',3,4-	52663-59-9	Y	Y,S+	Y+	Y,R	Y,H,S+
42	tetra	2,2',3,4'-	36559-22-5	Y	Y,S+	Y+	Y,R	Y,H,S+
43*	**tetra**	**2,2',3,5-**	**70362-46-8**	**Y**	**Y,S+**		**Y**	**Y,S**
44	tetra	2,2',3,5'-	41464-39-5	Y	Y,S	Y,R	Y,R	Y,H,S
47	tetra	2,2',4,4'-	2437-79-8	Y	Y,S	Y	Y,R	Y,H,S+
48	tetra	2,2',4,5-	70362-47-9	Y	Y,S	Y	Y,R	Y,H,S+
49	tetra	2,2',4,5'-	41464-40-8	Y	Y,S	Y,R	Y,R	Y,H,S
52	tetra	2,2',5,5'-	35693-99-3	Y	Y,S+	Y,R	Y,R	Y,H,S
53	tetra	2,2',5,6'-	41464-41-9	Y	Y,S+		Y,R	Y,S
56	tetra	2,3,3',4'-	41464-43-1	Y	Y,S+	Y+	Y,R	Y,H,S+
60	tetra	2,3,4,4'-	33025-41-1	Y	Y,S+	Y,R+	Y,R	Y,H,S+
64	tetra	2,3,4',6-	52663-58-8	Y	Y,S+	Y+	Y,R	Y,H,S+
66	tetra	2,3',4,4'-	32598-10-0		Y,S+	Y	Y,R	Y,S
70	tetra	2,3',4',5-	32598-11-1	Y	Y,S+	Y+	Y,R	Y,H,S+
71*	**tetra**	**2,3',4',6-**	**41464-46-4**	**Y**	**Y,S+**		**Y,R**	**Y,H,S+**

(continued)

TABLE I-3. SHORT LIST OF PRIORITY PCB CONGENERS (continued)

IUPAC Number	Type	Isomer	CAS Number	Mullin Std.	AES (A)	NWRI (P)	MOEE	ISWS
74	tetra	2,4,4',5-	32690-93-0	Y	Y,S	Y	Y,R	Y,S
75	tetra	2,4,4',6-	32598-12-2				Y	T
76*	**tetra**	**2',3,4,5-**	**70362-48-0**	**Y**	**Y,S+**	**Y+**	**Y,R**	**Y,H,S+**
77	tetra	3,3',4,4'-	32598-13-3	Y	Y,S+	Y,R+	Y,R	Y,T
81*	**tetra**	**3,4,4',5-**	**70362-50-4**	**Y**	**Y,S**	**Y+**	**Y,R**	**Y,S**
82	penta	2,2',3,3',4-	52663-62-4	Y	Y	Y	Y	Y,T
83	penta	2,2',3,3',5-	60145-20-2	Y	Y	Y		Y,T
84	penta	2,2',3,3',6-	52663-60-2	Y	Y,S+	Y+	Y,R	Y,H,S+
87	penta	2,2',3,4,5'-	38380-02-8	Y	Y,S+	R	Y,R	Y,S
91	penta	2,2',3,4',6-	68194-05-8	Y	Y	Y+		Y,T
92	penta	2,2',3,5,5'-	52663-61-3	Y	Y,S+	Y+	Y,R	Y,H,S+
95	penta	2,2',3,5',6-	38379-99-6	Y	Y,S+	Y	Y,R	Y,H,S
97	penta	2,2',3',4,5-	41464-51-1	Y	Y,S	Y	Y,R	Y
99	penta	2,2',4,4',5-	38380-01-7	Y	Y,S	Y	Y,R	Y,T,S
100	penta	2,2',4,4',6-	39485-83-1	Y	Y	Y		Y,T
101	penta	2,2',4,5,5'-	37680-73-2	Y	Y,S	Y,R	Y,R	Y,H,S,T
105	penta	2,3,3',4,4'-	32598-14-4	Y	Y,S	Y,R+	Y,R	Y,T,H,S+
110	penta	2,3,3',4',6-	38380-03-9	Y	Y,S+	Y	Y,R	Y,H,S
114	penta	2,3,4,4',5-	74472-37-0	Y	Y+	Y	Y,R	Y,T
118	penta	2,3',4,4',5-	31508-00-6	Y	Y,S	Y,R+	Y,R	Y,S
119	penta	2,3',4,4',6-	56558-17-9	Y	Y,S	Y	Y,R	Y,S
126	penta	3,3',4,4',5-	57465-28-8			Y+	Y,R	T
132	hexa	2,2',3,3',4,6'-	38380-05-1	Y	Y,S+	Y+	Y,R	Y,H,S+
134	hexa	2,2',3,3',5,6-	52704-70-8	Y	Y	Y+	Y	Y
138	hexa	2,2',3,4,4',5'-	35065-28-2	Y	Y,S+	Y+	Y,R	Y,H,S+
149	hexa	2,2',3,4',5',6-	38380-04-0	Y	Y,S	Y+	Y,R	Y,S
153	hexa	2,2',4,4',5,5'-	35065-27-1	Y	Y,S+	Y,R	Y,R	Y,S+
156	hexa	2,3,3',4,4',5-	38380-08-4	Y	Y+	Y,R+	Y,R	Y,T
163*	**hexa**	**2,3,3',4',5,6-**	**74472-44-9**	**Y**	**Y,S+**	**Y+**	**Y,R**	**Y,H,S+**
180	hepta	2,2',3,4,4',5,5'-	35065-29-3	Y	Y	Y,R	Y,R	Y

(continued)

TABLE I-3. SHORT LIST OF PRIORITY PCB CONGENERS (continued)

NOTES:

The short list of priority PCB congeners consists of those recommended for a suite of congeners or that were recommended by two or more organizations.
NLET determines total PCBs and not individual PCB congeners.
***** and **bold** are used to denote the 77 PCB congeners that do not exist in commercial mixtures.
indicates a coplanar PCB.
(A) indicates that the laboratory only analyzes air samples.
(P) indicates that the laboratory only analyzes precipitation samples.
"H" indicates a priority based on high concentration and "HV" a priority based on high concentration in the vapour phase.
"R" indicates a recommended priority based on either high concentration or toxicity.
"S" indicates a congener to be included in a PCB "suite" which regularly comprises between 90 and 95% of total mass of PCBs in ambient air or has been added because of its toxicity.
"T" indicates a recommended priority based on toxicity.
"Y" indicates a congener that is analyzed for or is present.
"+" indicates a congener that coelutes with another congener.

TABLE I-4. ANALYTICAL RECOVERIES FOR AIR ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES				ISWS
				Matrix Spikes[d]		SPE Spikes[e]		
				PUF	GFF	PUF	GFF	
Air Organics		75-120%/50-130%						
PCBs		75-120%/50-130%						50-130%
Total PCBs								
Congener # PCB 8	34883-43-7		100%					
Congener # PCB 18	37680-66-3		n/a					
Congener # PCB 49	41464-40-8		95%					
Congener # PCB 87	38380-02-8		90%					
Congener # PCB 158	74472-42-7		95%					
Congener # PCB 191	74472-50-7		100%					
Congener # PCB 198	68194-17-2		n/a					
Congener # PCB 206	40186-72-9		100%					
Congener # PCB 209	2051-24-3		90%					
Pesticides		75-120%/50-130%	-					
-HCH	319-84-6		95%					50-130%
-HCH	58-89-9		95%					50-130%
DDT (+ metabolites)			n/a					50-130%
p,p'-DDT	50-29-3		90%					50-130%
o,p'-DDD	53-19-0		n/a					n/a
p,p'-DDD	72-54-8		90%					50-130%
p,p'-DDE	72-55-9		100%					50-130%
chlordane	57-74-9		-					50-130%
-chlordane	5130-71-9		-					50-130%
-chlordane	5103-74-2		-					50-130%
nonachlor	3734-49-4		-					
trans-nonachlor	39765-80-5		-					50-130%
endrin	70-20-8		-					n/a
HCB	118-74-1		100%					50-130%
heptachlor epoxide	1024-57-3		-					n/a
methoxychlor	72-43-5		-					n/a
dieldrin	60-57-1		-					50-130%
PAHs		75-120%/50-130%	90-120%/ 70-130%					
benzo[a]pyrene	50-32-8		85.34%	68.82%	64.38%	86.11%	79.35%	50-130%
naphthalene	91-20-3		n/a	106.00%	82.27%	81.19%	77.97%	
acenaphthylene	208-96-8		95.68%	47.51%	58.55%	75.56%	69.81%	
acenaphthene	83-32-9		80.48%	63.08%	66.64%	73.57%	70.60%	
fluorene	86-73-1		81.51%	65.41%	80.06%	81.41%	83.42%	
phenanthrene	85-01-8		89.81%	108.30%	103.03%	86.46%	87.40%	
anthracene	120-12-7		82.27%	66.53%	61.04%	80.90%	80.61%	
fluoranthene	206-44-0		85.87%	71.94%	77.16%	82.20%	81.65%	
pyrene	129-00-0		86.41%	83.34%	84.01%	84.72%	82.00%	

(continued)

TABLE I-4. ANALYTICAL RECOVERIES FOR AIR ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES				ISWS
				Matrix Spikes[d]		SPE Spikes[e]		
				PUF	GFF	PUF	GFF	
triphenylene	217-59-4		n/a	81.67%	87.64%	89.96%	89.56%	
benzo(g,h,i)fluoranthene	203-12-3		n/a	72.37%	78.89%	80.06%	82.51%	
benzo[a]anthracene	56-55-3		89.03%	87.28%	86.27%	83.87%	83.83%	
chrysene	218-01-9		88.32%	73.23%	86.57%	88.22%	85.09%	
benzo[e]pyrene	192-97-2		89.31%	73.56%	89.97%	92.77%	96.06%	
benzo[b]fluoranthene	205-99-2		79.79%	97.84%	99.44%	97.84%	90.76%	
dibenzo[a,c]anthracene	215-58-7		91.82%	86.63%	99.82%	93.80%	98.55%	
benzo[k]fluoranthene	207-08-9		92.63%	98.30%	77.07%	91.90%	87.46%	
dibenz[a,h]anthracene	53-70-3		91.82%	67.12%	83.14%	96.32%	94.92%	
benzo[g,h,i]perylene	191-24-2		87.44%	68.56%	82.89%	94.42%	93.99%	
indeno[1,2,3-c,d]pyrene	193-39-5		90.14%	86.68%	88.72%	93.79%	92.01%	
anthanthrene	191-26-4		n/a	42.50%	26.53%	50.15%	60.94%	

[a] Analytical recovery, a measure of analytical accuracy, is defined in Section 3.1 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post -workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] Between-run mean recovery, based on equation 3-2 over 12 month period of data.
[d] Between-run mean recovery, based on equation 3-2, spiked onto Poly-urethane foam (PUF) and glass fibre filters (GFF). n = 15 - 26, depending on the parameter.
[e] Between-run mean recovery, based on equation 3-2, spiked onto clean-up column, Poly-urethane foam (PUF) and glass fibre filters (GFF). n = 10 - 39, depending on the parameter.
n/a Not applicable.

TABLE I-5. ANALYTICAL PRECISION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES				ISWS
				Matrix Spike[d]		SPE Spike[e]		
				PUF	GFF	PUF	GFF	
Air Organics		±40-80%/±50-100%						
PCBs		±40-80%/±50-100%						<50%
Total PCBs								
Congener # PCB 8	34883-43-7		±10-15%					
Congener # PCB 18	37680-66-3		-					
Congener # PCB 49	41464-40-8		±5-10%					
Congener # PCB 87	38380-02-8		±15-25%					
Congener # PCB 158	74472-42-7		±5-10%					
Congener # PCB 191	74472-50-7		±10-15%					
Congener # PCB 198	68194-17-2		-					
Congener # PCB 206	40186-72-9		±10-15%					
Congener # PCB 209	2051-24-3		±25-30%					
Pesticides		±40-80%/±50-100%	-					
-HCH	319-84-6		±10-20%					<50%
-HCH	58-89-9		±10-20%					<50%
DDT (+ metabolites)			-					<50%
p,p'-DDT	50-29-3		±15-30%					<50%
o,p'-DDD	53-19-0		-					n/a
p,p'-DDD	72-54-8		±15-25%					<50%
p,p'-DDE	72-55-9		±10-20%					<50%
chlordane	57-74-9		-					
-chlordane	5103-71-9		-					<50%
-chlordane	5103-74-2		-					<50%
nonachlor	3734-49-4		-					
trans-nonachlor	39765-80-5		-					<50%
endrin	70-20-8		-					n/a
HCB	118-74-1		±15-25%					<50%
heptachlor epoxide	1024-57-3		-					n/a
methoxychlor	72-43-5		-					n/a
dieldrin	60-57-1		-					
PAHs		±40-80%/±50-100%	±15-20%/ ±15-30%					<50%
benzo[a]pyrene	50-32-8		16.33%	15.96%	14.74%	13.72%	9.44%	
naphthalene	91-20-3		n/a	33.35%	16.61%	18.19%	15.15%	
acenaphthylene	208-96-8		30.28%	15.30%	9.26%	12.82%	5.31%	
acenaphthene	83-32-9		27.52%	15.49%	22.83%	12.95%	12.04%	
fluorene	86-73-1		29.56%	31.80%	27.75%	14.59%	13.03%	
phenanthrene	85-01-8		31.02%	38.02%	25.43%	15.10%	11.18%	
anthracene	120-12-7		36.94%	27.94%	7.85%	13.39%	8.54%	
fluoranthene	206-44-0		27.56%	19.47%	15.40%	14.49%	9.02%	
pyrene	129-00-0		27.16%	31.98%	24.13%	13.63%	11.09%	

(continued)

TABLE I-5. ANALYTICAL PRECISION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES				ISWS
				Matrix Spike[d]		SPE Spike[e]		
				PUF	GFF	PUF	GFF	
triphenylene	217-59-4		n/a	29.55%	20.43%	16.53%	9.30%	
benzo[g,h,i]fluoranthene	203-12-3		n/a	24.21%	15.54%	18.54%	8.71%	
benzo[a]anthracene	56-55-3		24.19%	31.97%	26.47%	14.28%	8.92%	
chrysene	218-01-9		24.08%	12.44%	21.46%	14.54%	10.06%	
benzo[e]pyrene	192-97-2		14.89%	14.40%	26.48%	13.84%	10.19%	
benzo[b]fluoranthene	205-99-2		29.40%	35.95%	24.51%	16.53%	12.96%	
dibenzo[a,c]anthracene	215-58-7		18.42%	23.67%	35.60%	19.78%	13.76%	
benzo[k]fluoranthene	207-08-9		17.09%	29.49%	20.04%	18.12%	9.75%	
dibenz[a,h]anthracene	53-70-3		18.42%	10.68%	17.20%	14.88%	8.34%	
benzo[g,h,i]perylene	191-24-2		13.06%	12.72%	17.49%	14.69%	9.76%	
indeno[1,2,3-c,d]pyrene	193-39-5		17.11%	32.00%	22.38%	17.45%	10.67%	
anthanthrene	191-26-4		n/a	9.55%	8.03%	26.92%	44.19%	

[a] Analytical precision is defined in Section 3.2 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.

[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post -workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.

[c] Between-run %RSD, based on equation 3-3 over 12 month period of data.

[d] Between-run %RSD, based on equation 3-3, spiked onto Poly-urethane foam (PUF) and glass fibre filters (GFF). n = 15 - 26, depending on the parameter.

[e] Between-run %RSD, based on equation 3-3, spiked onto clean-up column and processed with Poly-urethane foam (PUF) or glass fibre filters (GFF). n = 10-39, depending on the parameter.

n/a Not applicable.

TABLE I-6. OVERALL PRECISION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE	AES	ISWS[c]
Air Organics		±50-100%	N/A		<100/<50%
PCBs		±50-100%	N/A		<100/<50%
Total PCBs			N/A		
Congener # PCB 8	34883-43-7		N/A		
Congener # PCB 18	37680-66-3		N/A		
Congener # PCB 49	41464-40-8		N/A		
Congener # PCB 87	38380-02-8		N/A		
Congener # PCB 158	74472-42-7		N/A		
Congener # PCB 191	74472-50-7		N/A		
Congener # PCB 198	68194-17-2		N/A		
Congener # PCB 206	40186-72-9		N/A		
Congener # PCB 209	2051-24-3		N/A		
Pesticides		±50-100%	N/A		<100/50%
-HCH	319-84-6		N/A		<100/50%
-HCH	58-89-9		N/A		<100/50%%
DDT (+ metabolites)			N/A		<100/50%
p,p'-DDT	50-29-3		N/A		<100/50%
o,p'-DDD	53-19-0		N/A		n/a
p,p'-DDD	72-54-8		N/A		<100/50%
p,p'-DDE	72-55-9		N/A		<100/50%
chlordane	57-74-9		N/A		
-chlordane	5103-71-9		N/A		<100/50%
-chlordane	5103-74-2		N/A		<100/<50%
nonachlor	3734-49-4		N/A		
trans-nonachlor	39765-80-5		N/A		<100/50%
endrin	70-20-8		N/A		n/a
HCB	118-74-1		N/A		<100/50%
heptachlor epoxide	1024-57-3		N/A		n/a
methoxychlor	72-43-5		N/A		n/a
dieldrin	60-57-1		N/A		<100/50%
PAHs		±50-100%	N/A		<100/50%
benzo[a]pyrene	50-32-8		N/A		<100/50%

[a] Overall precision is defined in Section 3.2 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post -workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] 100% if values are <5 X LOD; 50% if values are >5 X LOD
n/a Not applicable.
N/A Not Available as of this revision of the QAPP.

TABLE I-7. LIMITS OF DETECTION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS - ng/m^3 [a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES[d]	ISWS	
Ambient Air Organics			ng/m^3	pg/m^3	Gas Phase[e], ng/m^3	Particulate Phase[f], ng/m^3
PCBs		0.003 ng/m^3	0.0004, except as noted			
Total PCBs						
Congener # PCB 1	2051-60-7			11.83		
Congener # PCB 3	2051-62-9			9.92		
Congener # PCB 4/10	13029-08-8/33146-45-1		0.001	7.94		
Congener # PCB 5/8	16605-91-7/34883-43-7		-/0.001	45.71 *	0.007108	0.000099
Congener # PCB 6	25569-80-6			6.50	0.000521	0.000021
Congener # PCB 7	33284-50-3			0.54		
Congener # PCB 12/13	2974-92-7			0.53		
Congener # PCB 15	2050-68-2					
Congener # PCB 16/32	38444-78-9/39444-77-8			8.92	0.00164	0.000058
Congener # PCB 17	37680-66-3			13.92	0.001593	0.000041
Congener # PCB 18	37680-65-2			12.19	0.002284	0.000074
Congener # PCB 19	38444-73-4			2.54		
Congener # PCB 21	55702-46-0			-	0.000734	0.000004
Congener # PCB 21/33/53	55702-46-0/38444-86-9/41464-41-9			14.08	-	-
Congener # PCB 22	38444-85-8			4.94	0.001533/-	0.000080/-
Congener # PCB 24/27	55702-45-9/38444-76-7			1.42		
Congener # PCB 25	55712-37-3			3.13		
Congener # PCB 26	38444-81-4			1.39		
Congener # PCB 28	7012-37-5			7.90	-	-
Congener # PCB 28/31	7012-37-5/16606-02-3			-	0.005761	0.000290
Congener # PCB 29	15862-07-4			3.07		
Congener # PCB 30	35693-92-6			4.69		
Congener # PCB 31	16606-02-3			5.44	-	-
Congener # PCB 33	38444-86-9				0.004521	0.000114
Congener # PCB 37/42	38444-90-5/36559-22-5			2.35	0.000831	0.000050
Congener # PCB 40	38444-93-8			0.87		
Congener # PCB 41/64/71	52663-59-9/52663-58-8/41464-46-4			4.11	0.001774	0.000284
Congener # PCB 43	70362-46-8			-	0.000145	0.000112
Congener # PCB 43/52	70362-46-8/35693-99-3			8.63	-	-
Congener # PCB 44	41464-39-5			8.67	0.00231	0.000148
Congener # PCB 45	70362-45-7			0.78		
Congener # PCB 46	41464-47-5			4.12		
Congener # PCB 47	2437-79-8			15.90	-	-
Congener # PCB 47/48	2437-79-8/70362-47-9			-	0.002773	0.000061
Congener # PCB 48	70362-47-9			0.15	-	-
Congener # PCB 49	41464-40-8			6.53	0.001158	0.000058
Congener # PCB 51	68194-04-7			1.86		
Congener # PCB 52	35693-99-3				0.001975	0.000075
Congener # PCB 53	41464-41-9				0.000195	0.000179
Congener # PCB 56/60	41464-43-1/33025-41-1			3.12	0.000568	0.000142
Congener # PCB 63	74472-34-7			0.30		
Congener # PCB 66	32598-10-0			-	0.000698	0.000047
Congener # PCB 66/95	32598-10-0/38379-99-6			8.40	-	-
Congener # PCB 70/76	32598-11-1/70362-48-0			4.67	0.001455	0.000637
Congener # PCB 74	32690-93-0			1.87	0.000399	0.000042
Congener # PCB 77/110	32598-13-3/38380-03-9			1.69		

(continued)

TABLE I-7. LIMITS OF DETECTION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS - ng/m^3 [a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES[d]	ISWS	
Congener # PCB 81	70362-50-4			-	0.000281	0.000070
Congener # PCB 81/87	70362-50-4/38380-02-8			1.07	-	-
Congener # PCB 82	52663-62-4			0.22		
Congener # PCB 83	60145-20-2			0.27		
Congener # PCB 84/92	52663-60-2/52663-61-3			3.57	0.000916	0.000127
Congener # PCB 85	65510-45-4			0.29		
Congener # PCB 87	38380-02-8			-	0.000548	0.000158
Congener # PCB 89	73575-57-2					
Congener # PCB 91	68194-05-8			0.35		
Congener # PCB 95	38379-99-6			-	0.001524	0.000119
Congener # PCB 97	41464-51-1			1.57		
Congener # PCB 99	38380-01-7			1.30	0.000335	0.000060
Congener # PCB 100	39485-83-1			0.15		
Congener # PCB 101	37680-73-2		0.02	1.69	0.001006	0.000172
Congener # PCB 105	32598-14-4		0.02	0.79	-	-
Congener # PCB 105/132/153	32598-14-4/38380-05-1/35065-27-1			-	0.001229	0.000281
Congener # PCB 107	70424-68-9			0.18		
Congener # PCB 110	38380-03-9				0.000964	0.000276
Congener # PCB 114	74472-37-0			0.45		
Congener # PCB 118	31508-00-6		0.02	1.17	0.000553	0.000378
Congener # PCB 119	56558-17-9			0.67	0.000147	0.000004
Congener # PCB 128	38380-07-3			0.49		
Congener # PCB 129/178	5521-18-4/52663-67-9			0.15		
Congener # PCB 130/137/176	52663-66-8/35694-06-5/52663-65-7			5.66		
Congener # PCB 131	61798-70-7			0.11		
Congener # PCB 132/153	38380-05-1/35065-27-1			6.67	-	-
Congener # PCB 134	52704-70-8			0.11		
Congener # PCB 135/144	52744-13-5/68194-14-9			0.26		
Congener # PCB 136	38411-22-2			0.71		
Congener # PCB 138/163	35065-28-2/74472-44-9			1.75	0.00066	0.000321
Congener # PCB 141	52712-04-6			1.48		
Congener # PCB 143	68194-15-0		0.02	n/a		
Congener # PCB 146	51908-16-8			0.47		
Congener # PCB 149	38380-04-0			1.24	0.001378	0.000387
Congener # PCB 151	52663-63-5			0.47		
Congener # PCB 156/171/202	38380-08-4/52663-71-5/2136-99-4		0.02/-/-	0.40		
Congener # PCB 157/200/204	69782-90-7/52663-73-7/74472-52-9			0.27		
Congener # PCB 158	74472-42-7			1.06		
Congener # PCB 167	52663-72-6			0.15		
Congener # PCB 170/190	35065-30-6/41411-64-7			0.37		
Congener # PCB 172/197	52663-74-8/33091-17-7			0.19		
Congener # PCB 174	38411-25-5			0.54		
Congener # PCB 175	40186-70-7			0.15		
Congener # PCB 177	52663-70-4			0.77		
Congener # PCB 180	35065-29-3		0.02	0.89		
Congener # PCB 182/187	60145-23-5/52663-68-0			0.42		
Congener # PCB 183	52663-69-1			0.19		
Congener # PCB 185	52712-05-7			0.19		
Congener # PCB 189	39635-31-9			0.33		
Congener # PCB 191	74472-50-7			0.23		
Congener # PCB 193	69782-91-8			0.23		

(continued)

TABLE I-7. LIMITS OF DETECTION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS - ng/m^{3} [a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES[d]	ISWS	
Congener # PCB 194	35694-08-7			0.29		
Congener # PCB 195/208	52663-78-2/52663-77-1			0.23		
Congener # PCB 196/203	42740-50-1/52663-76-0			2.51		
Congener # PCB 198	68194-17-2			0.31		
Congener # PCB 199	52663-75-9			0.23		
Congener # PCB 201	40186-71-8			0.28		
Congener # PCB 205	4472-53-0			0.23		
Congener # PCB 206	40186-72-9			0.23		
Congener # PCB 207	52663-79-3			0.23		
Congener # PCB 209	2051-24-3			0.23		
Pesticides		0.03 ng/m^3	0.001			
-HCH	319-84-6			1.72	0.002848	0.000263
ß-HCH	319-85-7			3.27		
-HCH	319-86-8			2.08		
-HCH	58-89-9			4.35	0.001663	0.000119
DDT (+ metabolites)			0.001			
p,p'-DDT	50-29-3			0.15	0.002847	0.000396
o,p'-DDT	784-02-6			0.43		
o,p'-DDD	53-19-0			0.30		
p,p'-DDD	72-54-8			0.19	0.00149	0.002008
p,p'-DDE	72-55-9			2.04	0.00103	0.000098
chlordane	57-74-9					
-chlordane	5103-71-9			0.25	0.002548	0.000065
-chlordane	5103-74-2			0.75	0.001898	0.000242
nonachlor	3734-49-4					
trans-nonachlor	39765-80-5			1.93	0.000780	0.000075
endrin	70-20-8			6.50		
HCB	118-74-1			9.98	0.00193	0.000059
heptachlor epoxide	1024-57-3			1.54		
methoxychlor	72-43-5			13.81		
dieldrin	60-57-1			0.90	0.001994	0.002403
heptachlor	76-44-8			2.25		
endosulfan I (a)	959-98-8			3.43		
endosulfan II (b)	33213-65-9			1.51		
aldrin	309-00-2			1.74	0.000012	0.000004
mirex	2385-85-5			0.08	0.000012	0.000004
photomirex	39801-14-4			0.19		
oxychlordane	26880-48-8			0.14		
PAHs		0.003 ng/m^3	0.008-0.04			
benzo[a]pyrene	50-32-8		0.008		0.014233	0.000408
acenaphthene	83-32-9		0.04		0.007117	0.000408
acenaphthylene	208-96-8		0.04		0.008712	0.000408
anthracene	120-12-7		0.04		0.001227	0.000408
benzo[a]anthracene	56-55-3		0.02		0.012761	0.004653
benzo[b]fluoranthene	205-99-2		0.04		0.020613	0.009429
benzo[k]fluoranthene	207-08-9		0.04		0.023926	0.008980
benzo[g,h,i]perylene	191-24-2		0.04		0.016319	0.007388
benzo(e)pyrene	192-97-2		0.04		0.001227	0.012653
chrysene	218-01-9		0.04		0.013865	0.006939
dibenzo[a,h]anthracene	53-70-3		0.04		0.006626	0.000408
fluoranthene	206-44-0		0.008		0.024172	0.015224

(continued)

TABLE I-7. LIMITS OF DETECTION FOR AIR ORGANICS CONCENTRATION MEASUREMENTS - ng/m^3 [a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	AES[d]	ISWS	
fluorene	86-73-7		0.02		0.021595	0.004653
indeno[1,2,3-c,d]pyrene	193-39-5		0.008		0.007239	0.018286
phenanthrene	85-01-8		0.04		0.036564	0.017837
pyrene	129-00-0		0.02		0.025399	0.033265
retene	483-65-8		n/a		0.050675	0.001224
coronene	191-07-1		n/a		0.001227	0.000408

[a] Limits of detection are defined in Section 3.3 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] The values listed for MOEE is a lowest reporting value (W) of 1 ng for PCBs (2.5 ng for di-PCBs) and 2.5 ng for other organics and a presumed sample volume of 2,500 m^3 (see section 3.3.5).
[d] Average sample volume for AES is 350 m^3 and LOD is calculated using equation 3-13.
[e] Average sample volume for ISWS airborne gas phase is 815 m^3 and LOD is calculated using equation 3-13.
[f] Average sample volume for ISWS airborne particulate phase is 2450 m^3 and LOD is calculated using equation 3-13.
n/a Not applicable.

TABLE I-8. COMPLETENESS GOALS FOR AIR ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE	AES	ISWS[c]
Air Organics				80%/66%	75%/66%
PCBs				80%/66%	75%/66%
Total PCBs		75%/66%	75%/66%	80%/66%	75%/66%
Congener # PCB 8	34883-43-7	"	"		
Congener # PCB 18	37680-66-3	"	"		
Congener # PCB 49	41464-40-8	"	"		
Congener # PCB 87	38380-02-8	"	"		
Congener # PCB 158	74472-42-7	"	"		
Congener # PCB 191	74472-50-7	"	"		
Congener # PCB 198	68194-17-2	"	"		
Congener # PCB 206	40186-72-9	"	"		
Congener # PCB 209	2051-24-3	"	"		
Pesticides		75%/66%	75%/66%	80%/66%	75%/66%
-HCH	319-84-6	"	"		75%/66%
-HCH	58-89-9	"	"		75%/66%
DDT (+ metabolites)		"	"		75%/66%
p,p'-DDT	50-29-3	"	"		75%/66%
o,p'-DDD	53-19-0	"	"		n/a
p,p'-DDD	72-54-8	"	"		75%/66%
p,p'-DDE	72-55-9	"	"		75%/66%
chlordane	57-74-9	75%/66%	75%/66%		75%/66%
-chlordane	1503-71-9				75%/66%
-chlordane	1503-74-2				75%/66%
nonachlor	3734-49-4	75%/66%	75%/66%		
trans-nonachlor	39765-80-5				75%/66%
endrin	70-20-8	75%/66%	75%/66%		n/a
HCB	118-74-1	"	"		75%/66%
heptachlor epoxide	1024-57-3	"	"		n/a
methoxychlor	72-43-5	"	"		n/a
dieldrin	60-57-1	"	"		75%/66%
PAHs		"	"	80%/66%	75%/66%
benzo[a]pyrene	50-32-8	"	"		75%/66%

[a] Completeness is defined in Section 3.4 of this appendix. The agreed-upon completeness goal for the IADN is 75% annually, 66% seasonally. Some groups may have higher completeness goals for their own programs.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] ISWS's completeness goals are listed as field/laboratory annual completeness.
n/a Not applicable.

TABLE I-9. ANALYTICAL RECOVERY FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d] n=8	NLET	ISWS
Precipitation Organics		75-120%/50-130%				
PCBs		75-120%/50-130%				50-130%
Total PCBs						50-130%
Congener # PCB 1	2051-60-7			86%		
Congener # PCB 3	2051-62-9			85%		
Congener # PCB 4/10	13029-08-8/33146-45-1			80%		
Congener # PCB 5/8	16605-91-7/34883-43-7		90%	88%		
Congener # PCB 6	25569-80-6			82%		
Congener # PCB 7	33284-50-3			79%		
Congener # 12/13	2974-92-7/2974-90-5			86%		
Congener # PCB 15	2050-68-2			n/a	n/a	
Congener # PCB 16	38444-78-9			84%		
Congener # PCB 17	37680-66-3			91%		
Congener # PCB 18	37680-65-2			95%		
Congener # PCB 19	38444-73-4			87%		
Congener # PCB 22/51	38444-85-8/68194-04-7			84%		
Congener # PCB 24/27	55702-45-9/38444-76-7			86%		
Congener # PCB 25	55712-37-3			90%		
Congener # PCB 26	38444-81-4			93%		
Congener # PCB 28	7012-37-5			88%		
Congener # PCB 31	16606-02-3			78%	n/a	
Congener # PCB 32	38444-77-8			95%		
Congener # PCB 33	38444-86-9			87%		
Congener # PCB 37/42	38444-90-5/36559-22-5			90%		
Congener # PCB 40	38444-93-8			93%	n/a	
Congener # PCB 41/64	52663-59-9/52663-58-8			89%		
Congener # PCB 44	41464-39-5			94%	n/a	
Congener # PCB 45	70362-45-7			80%		
Congener # PCB 46	41464-47-5			89%		
Congener # PCB 47	2437-79-8			84%		
Congener # PCB 48	70362-47-9			86%		
Congener # PCB 49	41464-40-8		95%	89%	n/a	
Congener # PCB 52	35693-99-3			93%	n/a	
Congener # PCB 53	41464-41-9			85%		
Congener # PCB 56/60	41464-43-1/33025-41-1			88%	n/a	
Congener # PCB 63	774472-34-7			91%		
Congener # PCB 66	32598-10-0			93%		
Congener # PCB 70/76	32598-11-1/70362-48-0			97%		
Congener # PCB 74	32690-93-0			89%		
Congener # PCB 77/136	32598-13-3/38411-22-2			98%	n/a	
Congener # PCB 81/87	70362-50-4/52663-68-0			91%		
Congener # PCB 82	52663-62-4			95%		
Congener # PCB 83	60145-20-2			89%		
Congener # PCB 84/92	52663-60-2/52663-61-3			84%		
Congener # PCB 85	65510-45-4			101%		
Congener # PCB 87	52663-68-0			-	n/a	
Congener # PCB 89	73575-57-2			94%		
Congener # PCB 91/121	68194-05-8/56558-18-0			89%		
Congener # PCB 95	38379-99-6			90%		
Congener # PCB 97	41464-51-1			96%		
Congener # PCB 99	38380-01-7			90%		

(continued)

TABLE I-9. ANALYTICAL RECOVERY FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d] n=8	NLET	ISWS
Congener # PCB 100	39485-83-1			91%		
Congener # PCB 101	37680-73-2		85%	87%	n/a	
Congener # PCB 105/132	32598-14-4/38380-05-1			103%	n/a	
Congener # PCB 107/123	70424-68-9/65510-44-3			99%		
Congener # PCB 110	38380-03-9			101%		
Congener # PCB 114/134	74472-37-0/52704-70-8			102%		
Congener # PCB 118/149	31508-00-6/38380-04-0			76%	n/a	
Congener # PCB 119	56558-17-9			94%		
Congener # PCB 126/178	57465-28-8			91%		
Congener # PCB 128	38380-07-3			105%		
Congener # PCB 129	55215-18-4			93%		
Congener # PCB 135/144	52744-13-5			106%		
Congener # PCB 137/176	35694-06-5/52663-65-7			95%		
Congener # PCB 138/163	35065-28-2/74472-44-9			96%		
Congener # PCB 141	52712-04-6		85%	111%		
Congener # PCB 143	68194-15-0			n/a	n/a	
Congener # PCB 146	51908-16-8			94%		
Congener # PCB 151	52663-63-5			89%		
Congener # PCB 153	35065-27-1			87%	n/a	
Congener # PCB 154	60145-22-4			n/a	n/a	
Congener # PCB 156/171/202	38380-08-4/52663-71-5/2136-99-4			95%	n/a	
Congener # PCB 157/200	69782-90-7			100%		
Congener # PCB 158	74472-42-7			89%		
Congener # PCB 167	52663-72-6			101%		
Congener # PCB 170	35065-30-6			106%		
Congener # PCB 172	52663-74-8			95%		
Congener # PCB 174	38411-25-5			98%		
Congener # PCB 175	40186-70-7			94%		
Congener # PCB 177	52663-70-4			85%		
Congener # PCB 180	35065-29-3			90%		
Congener # PCB 182/187	60145-23-5/52663-68-0			98%	n/a	
Congener # PCB 183	52663-69-1			99%		
Congener # PCB 185	52712-05-7		85%	100%		
Congener # PCB 189	39635-31-9			95%		
Congener # PCB 190	41411-64-7			100%		
Congener # PCB 191	74472-50-7			90%		
Congener # PCB 193	69782-91-8			98%		
Congener # PCB 194	35694-08-7			99%		
Congener # PCB 195/208	52663-78-2/52663-77-1			90%		
Congener # PCB 196/203	42740-50-1/52663-76-0			110%		
Congener # PCB 197	33091-17-7			92%		
Congener # PCB 198	68194-17-2			98%		
Congener # PCB 199	52663-75-9			91%		
Congener # PCB 201	40186-71-8		85%	98%		
Congener # PCB 205	4472-53-0			101%		
Congener # PCB 206	40186-72-9			99%		
Congener # PCB 207	52663-79-3			94%		
Pesticides		75-120%/50-130%		-		50-130%
-HCH	319-84-6		90%	80%	70-100%	50-130%
-HCH	58-89-9		90%	82%	70-100%	50-130%
DDT (+ metabolites)				-	80-120%	50-130%

(continued)

TABLE I-9. ANALYTICAL RECOVERY FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d] n=8	NLET	ISWS
p,p'-DDT	50-29-3		70%	89%	80-120%	50-130%
o,p'-DDD	53-19-0				80-120%	n/a
p,p'-DDD	72-54-8		75%	97%	80-110%	50-130%
p,p'-DDE	72-55-9		85%	93%	80-110%	50-130%
chlordane	57-74-9				80-110%	
-chlordane	5103-71-9			77%		50-130%
-chlordane	5103-74-2			70%		50-130%
nonachlor	3734-49-4				n/a	
trans-nonachlor	39765-80-5			n/a		50-130%
endrin	70-20-8		85%	96%	70-120%	n/a
HCB	118-74-1			94%	80-110%	50-130%
heptachlor epoxide	1024-57-3			95%	80-110%	n/a
methoxychlor	72-43-5			88%	80-130%	n/a
dieldrin	60-57-1			91%	80-110%	50-130%
heptachlor	76-44-8			78%		
endosulfan I (a)	959-98-7			82%		
endosulfan II (b)	33213-65-9			78%		
PAHs		75-120%/50-130%		n/a		50-130%
benzo[a]pyrene	50-32-8		85.34%	n/a	50-150%	

[a] Analytical recovery, a measure of analytical accuracy, is defined in Section 3.1 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] Based on matrix spikes
[d] Based on matrix spikes, using equation 3-2.
n/a Not applicable.

(continued)

TABLE I-10. ANALYTICAL PRECISION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d] n=8	NLET[e]	ISWS[f]
Precipitation Organics		±40-80%/±50-100%				<50% RPD
PCBs		±40-80%/±50-100%				<50% RPD
Total PCBs						<50% RPD
Congener # PCB 1	2051-60-7			±18%		
Congener # PCB 3	2051-62-9			±22		
Congener # PCB 4/10	13029-08-8/33146-45-1			±13%		
Congener # PCB 5/8	16605-91-7/34883-43-7		±15-25%	±22%		
Congener # PCB 6	25569-80-6			±25%		
Congener # PCB 7	33284-50-3			±26%		
Congener # PCB 12/13	2974-92-7/2974-90-5			±14%		
Congener # PCB 15	2050-68-2			n/a	n/a	
Congener # PCB 16	38444-78-9			±15%		
Congener # PCB 17	37680-66-3			±19%		
Congener # PCB 18	37680-65-2			±11%		
Congener # PCB 19	38444-73-4			±16%		
Congener # PCB 22/51	38444-85-8/68194-04-7			±24%		
Congener # PCB 24/27	55702-45-9/38444-76-7			±22%		
Congener # PCB 25	55712-37-3			±11%		
Congener # PCB 26	38444-81-4			±16%		
Congener # PCB 28	7012-37-5			±13%		
Congener # PCB 31	16606-02-3			±15%	n/a	
Congener # PCB 32	38444-77-8			±14%		
Congener # PCB 33	38444-86-9			±19%		
Congener # PCB 37/42	38444-90-5/36559-22-5			±22%		
Congener # PCB 40	38444-93-8			±14%	n/a	
Congener # PCB 41/64	52663-59-9			±26%		
Congener # PCB 44	41464-39-5			±8%	n/a	
Congener # PCB 45	70362-45-7			±14%		
Congener # PCB 46	41464-47-5			±13%		
Congener # PCB 47	2437-79-8			±11%		
Congener # PCB 48	70362-47-9			±16%		
Congener # PCB 49	41464-40-8		±15-20%	±13%	n/a	
Congener # PCB 52	35693-99-3			±16%	n/a	
Congener # PCB 53	41464-41-9			±18%		
Congener # PCB 56/60	41464-43-1/33025-41-1			±22%	n/a	
Congener # PCB 63	74472-34-7			±15%		
Congener # PCB 66	32598-10-0			±11%		
Congener # PCB 70/76	32598-11-1/70362-48-0			±21%		
Congener # PCB 74	32690-93-0			±16%		
Congener # PCB 77/136	32598-13-3/38411-22-2			±19%	n/a	
Congener # PCB 81/87	70362-50-4/38380-02-8			±16%		
Congener # PCB 82	52663-62-4			±24%		
Congener # PCB 83	60145-20-2			±11%		
Congener # PCB 84/92	52663-60-2			±18%		
Congener # PCB 85	65510-45-4			±22%		
Congener # PCB 87	38380-02-8			-	n/a	
Congener # PCB 89	73575-57-2			±19%		
Congener # PCB 91/121	68194-05-8/56558-18-0			±16%		
Congener # PCB 95	38379-99-6			±19%		
Congener # PCB 97	41464-51-1			±11%		
Congener # PCB 99	38380-01-7			±18%		

(continued)

TABLE I-10. ANALYTICAL PRECISION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d] n=8	NLET[e]	ISWS[f]
Congener # PCB 100	39485-83-1			±15%		
Congener # PCB 101	37680-73-2		±10-15%	±11%	n/a	
Congener # PCB 105/132	32598-14-4/38380-05-1			±29%	n/a	
Congener # PCB 107/123	70424-68-9			±27%		
Congener # PCB 110	38380-03-9			±19%		
Congener # PCB 114/134	74472-37-0/52704-70-8			±26%		
Congener # PCB 118/149	31508-00-6/38380-04-0			±22%	n/a	
Congener # PCB 119	56558-17-9			±15%		
Congener # PCB 126/178	574655-28-8			±28%		
Congener # PCB 128	38380-07-3			±25%		
Congener # PCB 129	55215-18-4			±23%		
Congener # PCB 135/144	52744-13-5/68194-14-9			±25%		
Congener # PCB 137/186	35694-06-5/74472-49-4			±24%		
Congener # PCB 138/163	35065-28-2/74472-46-1			±23%		
Congener # PCB 141	52712-04-6		±10-20%	±23%		
Congener # PCB 143	68194-15-0			n/a	n/a	
Congener # PCB 146	51908-16-8			±19%		
Congener # PCB 151	52663-63-5			±21%		
Congener # PCB 153	35065-27-1			±18%	n/a	
Congener # PCB 154	60145-22-4			n/a	n/a	
Congener # PCB 156/171/202	38380-08-4/52663-71-5/2136-99-4			±26%	n/a	
Congener # PCB 157/200	69782-90-7/52663-73-7			±19%		
Congener # PCB 158	74472-42-7			±22%		
Congener # PCB 167	52663-72-6			±20%		
Congener # PCB 170	35065-30-6			±26%		
Congener # PCB 172	52663-74-8			±16%		
Congener # PCB 174	38411-25-5			±24%		
Congener # PCB 175	40186-70-7			±21%		
Congener # PCB 177	52663-70-4			±22%		
Congener # PCB 180	35065-29-3			±24%	n/a	
Congener # PCB 182/187	60145-23-5			±22%		
Congener # PCB 183	52663-69-1			±26%		
Congener # PCB 185	52712-05-7		±15-25%	±19%		
Congener # PCB 189	39635-31-9			±19%		
Congener # PCB 190	41411-64-7			±30%		
Congener # PCB 191	74472-50-7			±29%		
Congener # PCB 193	69782-91-8			±28%		
Congener # PCB 194	35694-08-7			±27%		
Congener # PCB 195/208	52663-78-2/52663-77-1			±24%		
Congener # PCB 196/203	42740-50-1/52663-76-0			±17%		
Congener # PCB 197	33091-17-7			±26%		
Congener # PCB 198	68194-17-2			±26%		
Congener # PCB 199	52663-75-9			±21%		
Congener # PCB 201	40186-71-8		±15-25%	±23%		
Congener # PCB 205	4472-53-0			±29%		
Congener # PCB 206	40186-72-9			±32%		
Congener # PCB 207	52663-79-3			±21%		
Pesticides		±40-80%/±50-100%		-		<50% RPD
-HCH	319-84-6		±10-20%	±12%		
ß-HCH	319-85-7			±12%		
-HCH	58-89-9		±10-30%	±11%		

(continued)

TABLE I-10. ANALYTICAL PRECISION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d] n=8	NLET[e]	ISWS[f]
DDT (+ metabolites)				-		
p,p'-DDT	50-29-3		±10-30%	±7%		
o,p'-DDD	53-19-0			n/a		
p,p'-DDD	72-54-8		±10-25%	±11%		
p,p'-DDE	72-55-9		±10-15%	±3%		
chlordane	57-74-9			-		
-chlordane	5103-71-9			±12%		
-chlordane	5103-74-2			±9%		
nonachlor	3734-49-4			-		
trans-nonachlor	39765-80-5			n/a		
endrin	70-20-8			±19%		
HCB	118-74-1		±10-20%	±9%		
heptachlor epoxide	1024-57-3			±4%		
methoxychlor	72-43-5			n/a		
dieldrin	60-57-1			±7%		
heptachlor	76-44-8			±12%		
endosulfan I (a)	959-98-7			±16%		
endosulfan II (b)	33213-65-9			±15%		
PAHs		±40-80%/±50-100%	±10-20%	n/a		<50% RPD
benzo[a]pyrene	50-32-8		±10-20%	n/a		

[a] Analytical precision is defined in Section 3.2 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c]
[d] Based on matrix samples, using equation 3-3.
[e] NLET was unable to supply any values for analytical precision.
n/a Not applicable.

(continued)

TABLE I-11. OVERALL PRECISION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE	NWRI	NLET	ISWS[c]
Precipitation Organics		±50-100%	N/A			<100/<50%
PCB Congeners		±50-100%				<100/<50%
Total PCBs						
Pesticides		±50-100%				<100/<50%
-HCH	319-84-6					
-HCH	58-89-9					
DDT (+ metabolites)						
p,p'-DDT	50-29-3					
o,p'-DDD	53-19-0					
p,p'-DDD	72-54-8					
p,p'-DDE	72-55-9					
chlordane	57-74-9					
-chlordane	5103-71-9					
-chlordane	5103-74-2					
nonachlor	3734-49-4					
trans-nonachlor	39765-80-5					
endrin	70-20-8					
HCB	118-74-1					
heptachlor epoxide	1024-57-3					
methoxychlor	72-43-5					
dieldrin	60-57-1					
PAHs		±50-100%				<100/<50%
benzo[a]pyrene	50-32-8		n/a			

[a] Overall precision, determined from collocated samplers, is defined in Section 3.2 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] <100% of values <5 X LOD; <50% if values >5 X LOD.
N/A Not Available as of this revision of the QAPP.
n/a Not applicable.

TABLE I-12. LIMITS OF DETECTION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d]	NLET[e]	ISWS[f]
Precipitation Organics				All values in pg		ng/L
PCBs		0.06 ng/L/ 0.005 ng/L	0.02			
Total PCBs						
Congener # PCB 1	2051-60-7			2.8		
Congener # PCB 3	2051-62-9			4.5		
Congener # PCB 4/10	13029-08-8/33146-45-1			0.27		
Congener # PCB 5/8	16605-91-7/34883-43-7			1		0.06203
Congener # PCB 6	25569-80-6			3.5		0.01749
Congener # PCB 7	33284-50-3			0.17		
Congener # PCB 12/13	2974-92-7			0.2		
Congener # PCB 15	2050-68-2		0.02	n/a	n/a	
Congener # PCB 16	38444-78-9			0.3		-
Congener # PCB 16/32	38444-78-9/39444-77-8			-		0.04584
Congener # PCB 17	37680-66-3			0.3		0.01704
Congener # PCB 18	37680-65-2			0.4		0.01932
Congener # PCB 19	38444-73-4			0.2		
Congener # PCB 21	55702-46-0					0.0043
Congener # PCB 22/51	38444-85-8/68194-04-7			0.4		0.09443/-
Congener # PCB 24/27	55702-45-9/38444-76-7			0.2		
Congener # PCB 25	55712-37-3			0.3		
Congener # PCB 26	38444-81-4			0.3		
Congener # PCB 28	7012-37-5			0.5		-
Congener # PCB 28/31	7012-37-5/16606-02-3			-		0.07299
Congener # PCB 31	16606-02-3		0.02	0.2	n/a	-
Congener # PCB 32	39444-77-8			0.2		-
Congener # PCB 33	38444-86-9			0.2		0.06101
Congener # PCB 37/42	38444-90-5/36559-22-5			0.32		0.02253
Congener # PCB 40	38444-93-8		0.02	0.24	n/a	
Congener # PCB 41/64/71	52663-59-9/52663-58-8/41464-46-4			0.26		0.02213
Congener # PCB 43	70362-46-8					0.001
Congener # PCB 44	41464-39-5		0.02	0.21	n/a	0.04136
Congener # PCB 45	70362-45-7			0.2		
Congener # PCB 46	41464-47-5			0.2		
Congener # PCB 47	2437-79-8			0.4		-
Congener # PCB 47/48	2437-79-8/70362-47-9			-		0.01411
Congener # PCB 48	70362-47-9			0.4		-
Congener # PCB 49	41464-40-8		0.02	0.2	n/a	0.02303
Congener # PCB 52	35693-99-3		0.02	0.2	n/a	0.03162
Congener # PCB 53	41464-41-9			0.3		0.00208
Congener # PCB 56/60	41464-43-1/33025-41-1		/0.02	0.4	n/a	0.05233
Congener # PCB 63	74472-34-7			0.2		
Congener # PCB 66	32598-10-0			0.3		0.03442
Congener # PCB 70/76	32598-11-1/70362-48-0			0.3		0.06008
Congener # PCB 74	32690-93-0			0.2		0.01634
Congener # PCB 77	32598-13-3		0.02	0.1	n/a	
Congener # PCB 81/87	70362-50-4/38380-02-8			0.2		0.01654/-
Congener # PCB 82	52663-62-4			0.6		
Congener # PCB 83	60145-20-2			0.2		
Congener # PCB 84/92	52663-60-2/52663-61-3			0.5		0.04703
Congener # PCB 85	65510-45-4			0.3		

(continued)

TABLE I-12. LIMITS OF DETECTION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d]	NLET[e]	ISWS[f]
Congener # PCB 87	38380-02-8		0.02	-	n/a	0.03534
Congener # PCB 89	73575-57-2			0.1		
Congener # PCB 91/121	68194-05-8/56558-18-0			0.2		
Congener # PCB 95	38379-99-6			0.3		0.05133
Congener # PCB 97	41464-51-1			0.2		
Congener # PCB 99	38380-01-7			0.2		0.01447
Congener # PCB 100	39485-83-1			0.26		
Congener # PCB 101	37680-73-2		0.02	0.2	n/a	0.04529
Congener # PCB 105/132	32598-14-4/38380-05-1		0.02/-	0.3	n/a	
Congener # PCB 105/132/153	32598-14-4/38380-05-1/35065-27-1			-		0.16711
Congener # PCB 107/123	70424-68-9/65510-44-3			0.5		
Congener # PCB 110	38380-03-9			0.3		0.06617
Congener # PCB 114/134	74472-37-0			0.3		
Congener # PCB 118	31508-00-6		0.02	-		0.02794
Congener # PCB 118/149	31508-00-6/38380-04-0			0.2	n/a	-
Congener # PCB 119	56558-17-9			0.7		0.01845
Congener # PCB 126/178	57465-28-8/52663-67-9			0.3		
Congener # PCB 128	38380-07-3			0.6		
Congener # PCB 129	5521-18-4			0.9		
Congener # PCB 135/144	52744-13-5/68194-14-9			0.2		
Congener # PCB 136	38411-22-2			0.1		
Congener # PCB 137/176	35694-06-5/52663-65-7			0.2		
Congener # PCB 138/163	35065-28-2/74472-44-9			0.3		0.06726
Congener # PCB 141	52712-04-6			0.2		
Congener # PCB 143	68194-15-0		0.02	n/a	n/a	
Congener # PCB 146	51908-16-8			0.4		
Congener # PCB 149	38380-04-0					0.02904
Congener # PCB 151	52663-63-5			0.2		
Congener # PCB 153	35065-27-1		0.02	0.3	n/a	-
Congener # PCB 154	60145-22-4		0.02	n/a	n/a	
Congener # PCB 156/171/202	38380-08-4/52663-71-5/2136-99-4		0.02/-/-	0.3	n/a	
Congener # PCB 157/200	69782-90-7/52663-73-7			0.5		
Congener # PCB 158	74472-42-7			0.4		
Congener # PCB 167	52663-72-6			0.8		
Congener # PCB 170	35065-30-6			0.5		
Congener # PCB 172	52663-74-8			0.4		
Congener # PCB 174	38411-25-5			0.3		
Congener # PCB 175	40186-70-7			0.3		
Congener # PCB 177	52663-70-4			0.3		
Congener # PCB 180	35065-29-3		0.02	0.3	n/a	
Congener # PCB 182/187	60145-23-5/52663-68-0			0.3		
Congener # PCB 183	52663-69-1			0.3		
Congener # PCB 185	52712-05-7			0.3		
Congener # PCB 189	39635-31-9			0.4		
Congener # PCB 190	41411-64-7			0.3		
Congener # PCB 191	74472-50-7			0.4		
Congener # PCB 193	69782-91-8			0.3		
Congener # PCB 194	35694-08-7			0.3		
Congener # PCB 195/208	52663-78-2/52663-77-1			0.8		
Congener # PCB 196/203	42740-50-1/52663-76-0			0.7		
Congener # PCB 197	33091-17-7			0.5		

(continued)

TABLE I-12. LIMITS OF DETECTION FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE[c]	NWRI[d]	NLET[e]	ISWS[f]
Congener # PCB 198	68194-17-2			0.3		
Congener # PCB 199	52663-75-9			0.2		
Congener # PCB 201	40186-71-8			0.4		
Congener # PCB 205	4472-53-0			0.3		
Congener # PCB 206	40186-72-9			0.4		
Congener # PCB 207	52663-79-3			0.2		
Pesticides		0.15 ng/L/0.1 ng/L				
-HCH	319-84-6		0.05	0.2	0.4 pg	0.38244
ß-HCH	319-85-7			0.3		
-HCH	58-89-9		0.05	0.2	0.4 pg	0.22678
DDT (+ metabolites)					0.4 pg	
p,p'-DDT	50-29-3		0.05	0.9	0.4 pg	0.00697
o,p'-DDD	53-19-0		0.05	n/a	0.4 pg	
p,p'-DDD	72-54-8		0.05	0.9	0.4 pg	0.00297
p,p'-DDE	72-55-9		0.05	0.5	0.4 pg	0.05857
chlordane	57-74-9			-	0.4 pg	
-chlordane	5103-71-9		0.05	0.2		0.0621
-chlordane	5103-74-2		0.05	0.2		0.07204
nonachlor	3734-49-4			-		
trans-nonachlor	39765-80-5		n/a	n/a		0.03158
endrin	70-20-8		0.05	0.4	0.4 pg	
HCB	118-74-1		0.05	0.1	0.4 pg	0.08087
heptachlor epoxide	1024-57-3		0.05	0.3	0.4 pg	
methoxychlor	72-43-5		0.05	n/a	0.4 pg	
dieldrin	60-57-1		0.05	0.4	0.4 pg	0.12603
heptachlor	76-44-8			0.2		
endosulfan I (a)	959-98-8			0.2		
endosulfan II (b)	33213-65-9			0.5		
aldrin	309-00-2			0.3		0.003
mirex	2385-85-5			0.3		0.003
PAHs		0.15 ng/L/0.1 ng/L				
benzo[a]pyrene	50-32-8		2.0		30 pg	2.55
acenaphthene	83-32-9		10.0			0.34
acenaphthylene	208-96-8		10.0			0.1
anthracene	120-12-7		10.0			1.08
benzo[a]anthracene	56-55-3		5.0			0.23
benzo[b]fluoranthene	205-99-2		10.0			2.2
benzo[k]fluoranthene	207-08-9		10.0			0.1
benzo[g,h,i]perylene	191-24-2		10.0			0.78
benzo(e)pyrene	192-97-2		10.0			0.1
chrysene	218-01-9		10.0			0.32
dibenzo[a,h]anthracene	53-70-3		10.0			1.02
fluoranthene	206-44-0		2.0			3.42
fluorene	86-73-7		5.0			1.67
indeno[1,2,3-c,d]pyrene	193-39-5		2.0			1.01
phenanthrene	85-01-8		10.0			4.97
pyrene	129-00-0		5.0			2.95
retene	483-65-8		n/a			1.17
coronene	191-07-1		n/a			0.1

[a] Limits of detection are defined in Section 3.3 of this appendix. Numbers given for specific agencies may be compound specific values or represent the range of typical

(continued)

values depending on the compound and/or concentration range.

[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.

[c] The values listed for MOEE is a lowest reporting value (W) of 1 ng for PCBs (2.5 ng for di-PCBs) and 2.5 ng for other organics and a presumed sample volume and a presumed sample volume of 10 litres (see section 3.3.5).

[d] Detection limit is defined using equation 3-11, with a 95% confidence level.

[e] Detection limits are based on a 1 litre sample volume.

[f] Detection limits are based on an average sample volume of 10 litres and calculated using equation 3-13.

n/a Not applicable.

TABLE I-13. COMPLETENESS GOALS FOR PRECIPITATION ORGANICS CONCENTRATION MEASUREMENTS[a]

Parameter	CAS Number	Working Recommendation[b]	MOEE	NWRI[c]	IWD	ISWS[c]
Precipitation Organics					80%/60%	75%/66%
PCBs				96%	80%/60%	75%/66%
Total PCBs		75%/66%	75%/66%	96%		75%/66%
Congener # PCB 8	34883-43-7	75%/66%	75%/66%			
Congener # PCB 18	37680-66-3	75%/66%	75%/66%			
Congener # PCB 49	41464-40-8	75%/66%	75%/66%			
Congener # PCB 87	38380-02-8	75%/66%	75%/66%			
Congener # PCB 158	74472-42-7	75%/66%	75%/66%			
Congener # PCB 191	74472-50-7	75%/66%	75%/66%			
Congener # PCB 198	68194-17-2	75%/66%	75%/66%			
Congener # PCB 206	40186-72-9	75%/66%	75%/66%			
Congener # PCB 209	2051-24-3	75%/66%	75%/66%			
Pesticides		75%/66%	75%/66%	96%	80%/60%	75%/66%
-HCH	319-84-6	75%/66%	75%/66%	96%		75%/66%
-HCH	58-89-9	75%/66%	75%/66%			75%/66%
DDT (+ metabolites)		75%/66%	75%/66%	96%		75%/66%
p,p'-DDT	50-29-3	75%/66%	75%/66%	96%		75%/66%
o,p'-DDD	53-19-0	75%/66%	75%/66%	96%		n/a
p,p'-DDD	72-54-8	75%/66%	75%/66%	96%		75%/66%
p,p'-DDE	72-55-9	75%/66%	75%/66%	96%		75%/66%
chlordane	57-74-9	75%/66%	75%/66%			
-chlordane	5103-71-9			96%		75%/66%
-chlordane	5102-74-2			96%		75%/66%
nonachlor	3734-49-4	75%/66%	75%/66%			
trans-nonachlor	39765-80-5	75%/66%	75%/66%			75%/66%
endrin	70-20-8	75%/66%	75%/66%	96%		n/a
HCB	118-74-1	75%/66%	75%/66%	96%		75%/66%
heptachlor epoxide	1024-57-3	75%/66%	75%/66%	96%		n/a
methoxychlor	72-43-5	75%/66%	75%/66%	96%		n/a
dieldrin	60-57-1	75%/66%	75%/66%	96%		75%/66%
PAHs		75%/66%	75%/66%		80%/60%	75%/66%
benzo[a]pyrene	50-32-8	75%/66%	75%/66%			75%/66%

[a] Completeness is defined in Section 3.4 of this appendix. The agreed-upon completeness goal for the IADN is 75% annually, 66% seasonally. Some groups may have higher completeness goals for their own programs.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] NWRI's completeness goals are for laboratory annual completeness only.
[d] ISWS's completeness goals are listed as field/laboratory annual completeness.
n/a Not applicable.

TABLE I-14. ANALYTICAL RECOVERIES FOR AIR AND PRECIPITATION TRACE METAL CONCENTRATION MEASUREMENTS

Parameter	Working Recommendation[b]	MOEE[c]	AES[d]		NWRI	ISWS
Air Metals			Matrix Spikes	CRM		
Pb	<10%	<10%	103.6%	99.9%	n/a	
As		N/A	n/a	n/a	n/a	
Se		n/a	n/a	n/a	n/a	
Cd		<10%	102.1%	100.3%	n/a	
Al		N/A	105.5%	95.9%		
Cr			101.1%	100.9%		
Cu			107.8%	101.3%		
Zn		<10%	97.2%	99.5%		
Hg		n/a	n/a	n/a	n/a	
Other Air Parameters						
TOC	<20%		80-120%		n/a	±20%
TSP	--/<20%		<10%		n/a	±20%
PM-10	--/<20%				n/a	±20%
Precipitation Metals						
Pb	<10%	<10%	n/a		<10	
As		N/A	n/a		<10	
Se		n/a	n/a		<10	
Cd		<10%	n/a		<10	
Al		N/A				
Zn		<10%				
Hg		n/a	n/a		n/a	

[a] Accuracy is defined in Section 3.1 of this appendix. Accuracy numbers for air metals, other air parameters, and precipitation metals are for analytical accuracy. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] MOEE recovery values for Air Metals are based on aqueous materials.
[d] Mean recovery values for ICP analysis, calculated using equation 3-2. For matrix spikes, n=30. For the CRM, n=10.
n/a Not applicable.
N/A Not available.
-- indicates no initial recommendation.

TABLE I-15. ANALYTICAL PRECISION FOR AIR AND PRECIPITATION TRACE METAL CONCENTRATION MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES[d]		NWRI	ISWS
Air Metals			Matrix Spikes	CRM		
Pb	±15%	±5%	3.57%	3.75%	n/a	±20%
As		±5%	n/a	n/a	n/a	±20%
Se		n/a	n/a	n/a	n/a	±20%
Cd		±5%	3.74%	1.83%	n/a	±20%
Al		±5%	5.47%	3.03%	n/a	±20%
Cr			5.18%	1.29%		
Cu			3.71%	2.16%		
Zn		±5%	7.81%	2.76%	n/a	±20%
Hg		N/A	n/a	n/a	n/a	N/A
Other Air Parameters						
TSP	--/±20%		±10%		n/a	±20%
TOC	--/±20%		±15%		n/a	±20%
PM-10	--/±20%				n/a	±20%
Precipitation Metals						
Pb	±10%	±5%	n/a		±2.2	±20%
As		±5%	n/a		±4	±20%
Se		n/a	n/a		±2	±20%
Cd		±5%	n/a		±3.5	±20%
Al		±5%	n/a			±20%
Zn		±5%	n/a			±20%
Hg		N/A	n/a		N/A	N/A

[a] Precision is defined in Section 3.2 of this appendix. Precision numbers for air metals, other air parameters, and precipitation metals are for analytical precision. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] MOEE precision values for Air Metals are based on aqueous materials.
[d] Mean %RSD for ICP analysis, calculated using equation 3-3. For matrix spikes, n=30. For the CRM, n=10.
n/a Not applicable.
N/A Not available.

TABLE I-16. OVERALL PRECISION FOR AIR AND PRECIPITATION TRACE METAL CONCENTRATION MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES	NWRI	ISWS
Air Metals					
Pb	±20%	±20%		n/a	
As		±20%		n/a	
Se		n/a		n/a	
Cd		±20%		n/a	
Al		±20%		n/a	
Zn		±20%		n/a	
Hg		N/A	N/A	n/a	N/A
Other Air Parameters					
TSP	--/±20%		±15%	n/a	±20%
TOC	--/±20%		±20%	n/a	±20%
PM-10	--/±20%			n/a	±20%
Precipitation Metals					
Pb	±15%	±15%	n/a		
As		±10%	n/a		
Se		n/a	n/a		
Cd		±10%	n/a		
Al		±10%			
Zn		±10%			
Hg		N/A	n/a	N/A	N/A

[a] Precision is defined in Section 3.2 of this appendix. Precision numbers for air metals, other air parameters, and precipitation metals are for overall precision. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range.

[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.

[c] MOEE overall precision is a target value. Some stations may have greater acceptable range of precision because of season, remoteness of location, or other factors.

n/a Not applicable.

TABLE I-17. LIMITS OF DETECTION FOR AIR AND PRECIPITATION TRACE METAL CONCENTRATION MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES		NWRI	ISWS[f, g]
Air Metals			ICP[d]	NAA[e]		
Pb	1 ng/m^3	0.03 ng/m^3	1.98 ng/m^3	N/A	n/a	0.073854 ng/m^3
As	0.012 ng/m^3 / 0.1 ng/m^3	0.1 ng/m^3	N/A	0.13 ng/m^3	n/a	0.019479 ng/m^3
Se	0.1 ng/m^3	n/a	N/A	0.39 ng/m^3	n/a	0.007188 ng/m^3
Cd	0.24 ng/m^3 / 0.1 ng/m^3	0.1 ng/m^3	0.27 ng/m^3	N/a	n/a	0.103229 ng/m^3
Al		0.1 ng/m^3	23.76 ng/m^3	53.85 ng/m^3	n/a	0.841667 ng/m^3
Cr		n/a	1.27 ng/m^3	5.41 ng/m^3	n/a	0.018438 ng/m^3
Cu		n/a	2.28 ng/m^3	21.60 ng/m^3	n/a	0.019792 ng/m^3
Zn		0.2 ng/m^3	20.52 ng/m^3	2.70 ng/m^3	n/a	0.035792 ng/m^3
Hg		N/A	N/A	N/A	n/a	n/a
Other Air Parameters						
TSP					n/a	
TOC					n/a	
PM-10					n/a	
Precipitation Metals						
Pb	--/ 0.1 ng/L	0.02 µg/L	n/a		0.2	10 ng/L
As		0.1 µg/L	n/a		0.1	20 ng/L
Se		n/a	n/a		2	100 ng/L
Cd		0.05 µg/L	n/a		0.1	7 ng/L
Al		0.05 µg/L	n/a			10 ng/L
Cr						40 ng/L
Cu						6 ng/L
Zn		0.1 µg/L	n/a			6 ng/L
Hg		N/A	n/a		N/A	N/A
Sample Volume						
Air	n/a	n/a				n/a
Precipitation	0.02 cm	0.02 cm	n/a	n/a	0.05 cm	0.02 cm

[a] Limits of detection are defined in Section 3.3 of this appendix.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] MOEE reports W instead of LOD. W = the smallest reporting increment (2/3* rounded to the nearest 1, 2, or 5). Air LOD's are based on an average air volume of 80 m^3. Precipitation LOD's are based on a presumed sample volume of 10 litres.
[d] ICP analysis performed on one strip of the filter after a water extraction. LOD is based on a presumed sample volume of 1600 m^3. ICP analysis for Aluminum has a systematic bias of 50% of the NAA results.
[e] NAA analysis performed on a second strip of the filter. LOD is based on a presumed sample volume of 1600 m^3.
[f] ISWS LOD's for airborne particulate metals are based on a presumed sample volume of 96 m^3.
[g] ISWS does not have LOD's available for precipitation samples. Values provided are IDL's (equation 3-10).
N/A Not Available.
n/a Not applicable.
-- indicates no initial recommendation.

TABLE I-18. ACCURACY FOR GENERAL FIELD MEASUREMENTS AND METEOROLOGICAL MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES	NWRI	ISWS
Sample Volume					
Air	<10%/<20%	<10%		n/a	<20%
Precipitation	<10%	<10%			<10%
Meteorology					
Temperature	<0.5%		0.5 C	n/a	±0.5 C
Relative Humidity	<20%		5%	n/a	<20%
Wind Speed	<5%		1 m/s	n/a	<5%
Wind Direction	<5		<±5	n/a	<5
Precipitation Amount	<5%		0.1 mm	n/a	<5%
Barometric Pressure	<0.5%		0.1 lba	n/a	n/a
Solar Irradiation	<5%		10 μs/m^2	n/a	<5%

[a] Accuracy is defined in Section 3.1 of this appendix. Accuracy numbers for meteorological parameters are based on the use of collocated transfer standards or factory calibration.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] MOEE obtains meterological data from AES.
n/a Not applicable.

TABLE I-19. PRECISION FOR AIR GENERAL FIELD MEASUREMENTS AND METEOROLOGICAL MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES	NWRI	ISWS
Sample Volume					
Air	±10%	±10%		n/a	±20%
Precipitation	±10%	±10%			±20%
Meteorology					
Temperature	±5%		0.5 C	n/a	±5%
Relative Humidity	±20%		±10%	n/a	±20%
Wind Speed	±10%		±10%	n/a	±10%
Wind Direction	±10		±10%	n/a	±10
Precipitation Amount	±10%		±10%	n/a	±10%
Barometric Pressure	±5%		0.1%	n/a	n/a
Solar Irradiation	±10%		±10%	n/a	±10%

[a] Precision is defined in Section 3.2 of this appendix. Precision numbers for air metals, other air parameters, and precipitation metals are for analytical precision. Numbers given for specific agencies may be compound specific values or represent the range of typical values depending on the compound and/or concentration range. Precision numbers for meteorological parameters are based on the use of collocated transfer standards or factory calibration.
[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.
[c] MOEE obtains meterological data from AES.
n/a Not applicable.

TABLE I-20. OVERALL PRECISION FOR GENERAL FIELD MEASUREMENTS AND METEOROLOGICAL MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES	NWRI	ISWS
Sample Volume					
Air	±10%	±10%		n/a	±10%
Precipitation	±10%	±10%, 0.02 cm			±10%
Meteorology					
Temperature	±5%,0.5 C		0.5 C	n/a	±5%
Relative Humidity	±20%		±5%	n/a	±20%
Wind Speed	±10%		±10%	n/a	±10%
Wind Direction	±10		±10%	n/a	±10
Precipitation Amount	±10%		±10%	n/a	±10%
Barometric Pressure	±5%		±0.1%	n/a	n/a
Solar Irradiation	±10%		10%	n/a	±10%

[a] Precision is defined in Section 3.2 of this appendix. Precision numbers for meteorological parameters are based on the use of collocated transfer standards or factory calibration.

[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.

[c] MOEE obtains meterological data from AES.

n/a Not applicable.

TABLE I-21. COMPLETENESS[a] GOALS FOR AIR AND PRECIPITATION TRACE METAL CONCENTRATION MEASUREMENTS, GENERAL FIELD MEASUREMENTS, AND METEOROLOGICAL MEASUREMENTS[a]

Parameter	Working Recommendation[b]	MOEE[c]	AES	NWRI	ISWS
Air Metals	>80%/60% / >75%/66%	75%/66%	>80%/66%	n/a	75%/66%
Pb	>80%/60% / >75%/66%	"		n/a	75%/66%
As	>80%/60% / >75%/66%	"		n/a	75%/66%
Se	>80%/60% / >75%/66%	"		n/a	75%/66%
Cd	>80%/60% / >75%/66%	"		n/a	75%/66%
Hg		n/a		n/a	n/a
Other Air Parameters					
TSP	----/ >75%/66%			n/a	75%/66%
TOC	----/ >75%/66%			n/a	75%/66%
PM-10	----/ >75%/66%			n/a	75%/66%
Precipitation Metals	>80%/60% / >75%/66%	75%/66%	n/a	90%	
Pb	>80%/60% / >75%/66%	"	n/a	90%	75%/66%
As	>80%/60% / >75%/66%	"	n/a	90%	75%/66%
Se	>80%/60% / >75%/66%	"	n/a	90%	75%/66%
Cd	>80%/60% / >75%/66%	"	n/a	90%	75%/66%
Hg		n/a	n/a	n/a	n/a
Sample Volume					
Air	>95%/90%	>95%/90%		n/a	>95%/90%
Precipitation	>95%/90%	>95%/90%			>95%/90%
Meteorology					
Temperature	>95%/90%		95%/90%	n/a	>95%/90%
Relative Humidity	>95%/90%		95%/90%	n/a	>95%/90%
Wind Speed	>95%/90%		95%/90%	n/a	>95%/90%
Wind Direction	>95%/90%		95%/90%	n/a	>95%/90%
Precipitation Amount	>95%/90%		95%/90%	n/a	>95%/90%
Barometric Pressure	>95%/90%		95%/90%	n/a	n/a
Solar Irradiation	>95%/90%		95%/90%	n/a	>95%/90%

[a] Completeness is defined in Section 3.4 of this appendix. The agreed-upon completeness goal for the IADN is 75% annually, 66% seasonally for organics and trace metals measurements. Some groups may have higher completeness goals for their own programs.

[b] Working recommendation is the initial proposed recommendation for the DQI. Where the recommendation has been changed based on agency responses to a post-workshop survey questionnaire, it is listed as initial/final. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.

[c] MOEE obtains meterological data from AES.

n/a Not applicable.

TABLE I-22. FINAL WORKING RECOMMENDATIONS FOR DQIs FOR GENERAL CONCENTRATION AND FIELD MEASUREMENTS[a]

Parameter	Accuracy[b]	Analytical Precision[c]	Overall Precision[d]	LOD[e]	Completeness[f]
Air Organics	50-130%	±50-100%	±50-100%	0.003 ng/m^3	>75%/66%
PCBs	50-130%	±50-100%	±50-100%	0.003 ng/m^3	>75%/66%
Pesticides	50-130%	±50-100%	±50-100%	0.003 ng/m^3	>75%/66%
PAHs	50-130%	±50-100%	±50-100%	0.003 ng/m^3	>75%/66%
Air Metals					>75%/66%
Pb	<10%	±15%	±20%	30 ng/m^3	>75%/66%
Other Air Parameters					
TOC	<20%	±20%	±20%		
TSP	<20%	±20%	±20%		
PM10	<20%	±20%	±20%		
Precipitation Organics	50-130%	±50-100%	±50-100%		>75%/66%
PCBs	50-130%	±50-100%	±50-100%	0.005 ng/L	>75%/66%
Pesticides	50-130%	±50-100%	±50-100%	0.1 ng/L	>75%/66%
PAHs	50-130%	±50-100%	±50-100%	0.1 ng/L	>75%/66%
Precipitation Metals					>75%/66%
Pb	<10%	±10%	±15%	0.1 ng/L	>75%/66%
Sample Volume	<10%	±10%	±10%		>95%/90%
Air	<10%	±10%	±10%	n/a	>95%/90%
Precipitation	<10%	±10%	±10%, 0.02 cm	0.02 cm	>95%/90%
Meteorology					>95%/90%
Temperature	<5%, 0.5 C	±5%	±5%	n/a	>95%/90%
Relative Humidity	<20%	±20%	±20%	n/a	>95%/90%
Wind Speed	<5%, 1 m/s	±10%	±10%	n/a	>95%/90%
Wind Direction	<5	±10	±10%	n/a	>95%/90%
Precipitation Amount	<5%	±10%	±10%	n/a	>95%/90%
Pressure	<5%	±5%	±5%	n/a	>95%/90%
Solar Irradiation	<5%	±10%	±10%	n/a	>95%/90%

[a] Final working recommendations are based on the initial proposed recommendation for the DQI and any changes that resulted from a review of post-workshop questionnaire responses. Numbers may be specific values or represent the range of typical values depending on the compound or class of compounds and/or the concentration range. All DQI recommendations should be reviewed and approved by the operations and QA workgroups.

[b] Accuracy is defined in Section 3.1 of this appendix. Accuracy numbers for air and precipitation organics and air and precipitation metals are analytical accuracy numbers based on analytical recoveries. Accuracy numbers for TSP and PM10 are based on flow accuracy while TOC numbers are based on a combination of analytical recovery and flow accuracy. Accuracy numbers for meteorological parameters are based on either a collocated transfer standard or factory calibration.

[c] Precision is defined in Section 3.2 of this appendix. Precision numbers for meteorological parameters are based on either a collocated transfer standard or factory calibration.

[d] Precision is defined in Section 3.2 of this appendix. Overall precision numbers for all organics and metals in air and precipitation, as well as other air parameters, are based on the results of collocated samplers. Precision numbers for meteorological parameters are based on either a collocated transfer standard or factory calibration.

[e] Limits of detection are defined in Section 3.3 of this appendix. Detection limits are based primarily on MDLs. LOD's for organics in precipitation are based on a presumed sample volume of 10 litres.

[f] Completeness is defined in Section 3.4 of this appendix. Completeness is given as overall completeness for a year and season. Overall completeness is the product of field and laboratory completeness.

N/A Not applicable.

TABLE I-23. SUMMARY OF MEASURES FOR DQI's

Parameter	DQI	Measure(s)	Comments
Air Organics Concentrations	Analytical Recovery	%R(MS), %R(SRM)	Using lab matrix spike (LMS), lab surrogate spike (LSS), standard reference material (SRM)
	Flow Accuracy	%Difference	Calibration with transfer standard
	Analytical Precision	RPD(dupl.), RSD(repl.)	Using LMS, LSS - may be further defined for within/between runs
	Overall Precision	RPD(dupl.), MAD(D)	Collocated samples
	Detection Limit	IDL, MDL, LOD	Using lab blank (LB), lab matrix blank (LMB), field blank (FB), and low concentration solutions
	Overall Completeness	%VSMP = %C	By site for year, season
Precipitation Organics Concentrations	Analytical Recovery	%R(MS), %R(SRM)	Using LMS, LSS
	Analytical Precision	%Difference	Using LMS, LSS - may be further defined for within/between runs
	Overall Precision	RPD(dupl.), MAD(D)	Collocated samples
	Detection Limit	IDL, MDL, LOD	Using LB, LMB, FB, and low concentration solutions
	Overall Completeness	%VSMP = %C	By site for year, season; other measures optional
Air Metals Concentrations	Analytical Recovery	%R(MS), %R(SRM)	Using LMS, LSS
	Flow Accuracy	%Difference	Calibration with transfer standard
	Analytical Precision	RPD(dupl.), RSD(repl.)	Using LMS, split samples, repeat measurements - may be further defined for within/between runs
	Overall Precision	RPD(dupl.), MAD(D)	Not measured currently; recommend collocated samples for each site at least once per season (quarter)
	LOD	Not Specified	To be specified
	Overall Completeness	%C	By site for year, season
Other Air Parameters	Flow Accuracy	%Difference	Calibration with transfer standard
TSP, PM10, TOC	Analytical Precision	RPD(dupl.), RSD(repl.)	Using LMS, split samples, repeat measurements - may be further defined for within/between runs
	Overall Precision	RPD(dupl.), MAD(D)	Not measured currently; recommend collocated samples for each site at least once per season (quarter)
	LOD	Not Specified	To be specified
	Overall Completeness	%C	By site for year, season

(continued)

TABLE I-23. SUMMARY OF MEASURES FOR DQI's (continued)

Parameter	DQI	Measure(s)	Comments
Precipitation Metals Concentrations	Analytical Recovery	%R(MS), %R(SRM)	Using LMS, LSS
	Analytical Precision	RPD(dupl.), RSD(repl.)	Using LMS, split samples, repeat measurements - may be further defined for within/between runs
	Overall Precision	RPD(dupl.), MAD(D)	Collocated samples
	LOD	Not Specified	To be specified
	Overall Completeness	%VSMP = %C	By site for year, season; other measures optional
Meteorological Parameters	Accuracy	%Difference	Using collocated transfer standard or factory calibration
T, RH, WS, WD, Precip. Amt., P	Precision	Not specified	To be specified
Solar Irradiation	Completeness	%C	By site for year, season

%C = Percent complete
%R = Analytical recovery in percent
% VSMP = Percent valid samples
FB = Field blank
IDL = Instrument detection limit
LB = Laboratory blank

LMS = Laboratory matrix spike
LOD = Limit of detection
LSS = Laboratory surrogate spike
MDL = Method detection limit
MS = Matrix spike
RPD = Relative percent difference

RSD = Relative standard deviation
SRM = Standard reference material
These terms are further defined in Section 3.0 of this appendix and the Glossary in Appendix A.